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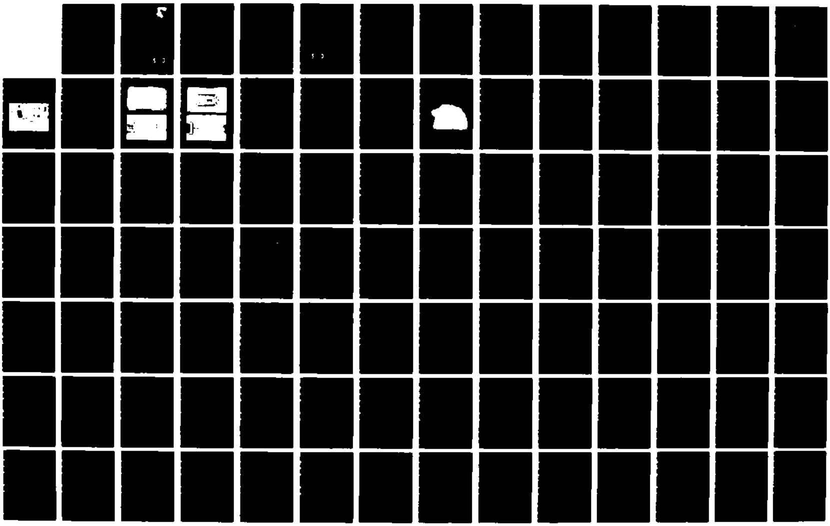

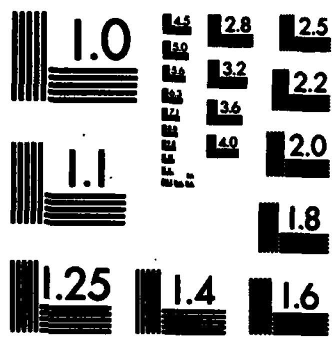

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Aerospace Medical Research Laboratory

IMPACT TESTS OF AUTOMATIC LAP BELT CONFIGURATIONS

JAMES W. BRINKLEY
DALE E. SCHIMMEL, MSgt, USAF

JULY 1984

Approved for public release; distribution unlimited.

AIR FORCE AEROSPACE MEDICAL RESEARCH LABORATORY
AEROSPACE MEDICAL DIVISION
AIR FORCE SYSTEMS COMMAND
WRIGHT-PATTERSON AIR FORCE BASE OHIO 45433

NOTICES

TECHNICAL REVIEW AND APPROVAL

AFAMRL-TR-84-041

This report has been reviewed by the Office of Public Affairs (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER

Henning E. von Gierke

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Director
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Air Force Aerospace Medical Research Laboratory

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Sixteen impact tests of lap belt assemblies were performed to evaluate components for the HBU-X lap belt (now designated the HBU-12 lap belt). The lap belt assemblies were tested as part of a lap belt and shoulder harness configuration. Fifteen tests were conducted at a level of 40 G (mean = 40.2 G, S.D. = 0.898) with an average impact velocity of 105.7 ft/sec (S.D. 0.976). The impact vector was applied in the $-G_x$ direction. The primary purpose of the tests was to evaluate the effectiveness of two different types of webbing adjusters. The influence of nylon, polyester, and latex-impregnated polyester was also studied. The results of the impact tests and several modes of failure including belt slippage through the adjusters and fracture of the metal attachment link of the MB-6 shoulder harness are described. Revision of design and test load conditions are recommended. Originator-supplied Keywords include; Restraint,

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PREFACE

This report was prepared by the Biomechanical Protection Branch, Biodynamics and Bioengineering Division of the Air Force Aerospace Medical Research Laboratory. The testing and evaluation effort that is described within this report was accomplished as directed by Program Management Plan No. 105 ASD/AES, Air Force Program Management Directive No. R-P2030/64706F/412A as amended by PMDR-P2030 (11) 64706F/412A, dated 10 March 1980. CMSgt Donald L. Wennen was Program Manager, and Mr Robert M. Dixon was Program Engineer for the Life Support System Program Office of the Aeronautical Systems Division.

The impact facilities, data acquisition equipment, and data processing system were operated by the Scientific Services Division of the Dynalectron Corporation under Air Force Contract F33615-79-C-0523. Mr Harold F. Boedeker was the Engineering Supervisor for the Dynalectron Corporation.

Photographic data and documentation services were provided by the Technical Photographic Division of the 4950th Test Wing.

The authors are grateful to the many personnel of the Biomechanical Protection Branch who participated in the planning, accomplishment, and documentation of this test and evaluation effort. Special acknowledgement is given to Mr Herman Engel of the Crew Equipment and Human Factors Division, Directorate of Equipment Engineering, Aeronautical Systems Division, for his technical consultation.

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SUMMARY

Sixteen tests were performed to evaluate the adequacy of various HBU-X lap belt assemblies to provide adequate restraint during impact. The tests were performed using the AFAMRL Impulse Accelerator. The lap belt assemblies were used in combination with MB-6 shoulder harnesses to restrain the 95th percentile test dummies to a simulated aircraft crewseat during the impact tests. One test was performed at an acceleration level of 32.8 G, and 15 tests were accomplished at an acceleration level of 40 G. The mean peak acceleration of the 15 tests was 40.2 G (standard deviation = 0.898) with an impact velocity of 105.7 ft/sec (standard deviation = 0.976).

The primary objective of the tests was to determine the acceptability of two different types of webbing adjusters that could be used with a buckle developed by the Frost Engineering Development Corporation. The two types of adjusters tested were manufactured by East/West Industries Incorporated and H. Koch and Sons.

A secondary objective of the tests was to study the influence of webbing material on belt slippage through the lap belt adjusters. Nylon, polyester, and latex-impregnated polyester webbing materials were used.

Two types of lap belt buckles were used. Eleven tests were performed with the HBU-X buckle supplied by Frost Engineering Development Corporation. Five tests were conducted using the HBU-2B/A buckle since the supply of Frost buckles was limited.

Ten impact tests were performed with the Koch adjusters. One test was performed at 32.8 G, and nine tests were accomplished at the 40 G level. Seven of the 40 G tests were failures of the adjusters due to lap belt slippage. One test was considered to be an inadequate test of the lap belt and adjusters due to shoulder harness failure, and one test was an inadequate test of the adjusters due to failure of the automatic release mechanism of the belt buckle.

Six impact tests were performed at the 40 G level using the East/West adjusters. Five of these tests were successful. One test was an inadequate test of the adjusters due to failure of the attaching link of the shoulder harness.

The impact tests that were performed demonstrated that the East/West adjusters could successfully withstand the lap belt loads imposed during the 40 G impact tests. The East/West adjuster permitted no more than one-half inch slippage of webbing when used with nylon, polyester, or latex-impregnated polyester webbing.

The failures of the attachment links of the MB-6 shoulder harness reflect a basic inadequacy in the design of the link. Redesign of the link is recommended.

Failures of the automatic disconnect mechanism of the Frost lap belt buckle were caused by loads of a magnitude and direction that were not anticipated by the HBU-X lap belt development specification. The development specification presumed that the lap belt would always be used with a negative-G strap as well as a shoulder harness. This presumption is not true and leads to unrealistic design-load assumptions.

SECTION 1

INTRODUCTION

A. BACKGROUND

An impact test program conducted to evaluate prototypes of the HBU-X automatic opening lap belt developed by three competing companies indicated that none of the preproduction prototypes were satisfactory (Brinkley and Schimmel, 1982). Each prototype failed to meet the acceptance criteria of the 40 G level impact tests that were accomplished.

Each of the HBU-X prototypes failed for different reasons. One prototype, developed by the Stencel Aero Engineering Corporation, apparently failed because a sharp radius on the belt buckle contributed to the failure of the belt webbing material. A second prototype, developed by the Frost Engineering Development Corporation, failed because the webbing adjusters permitted the belt to slip through them during the impact exposure. A third prototype, developed by H. Koch and Sons, failed due to defects within the materials used in the construction of the lap belt buckle.

The Air Force Aerospace Medical Research Laboratory (AFAMRL) recommended further impact tests. A successful lap belt assembly was considered to be possible if the adjuster slippage problem of the Frost prototype could be overcome by using other webbing adjusters. After consideration of the AFAMRL recommendation and the success of the Frost prototype in other aspects of the overall HBU-X lap belt evaluation test program, the Life Suppport System Program Office, the sponsor of the HBU-X lap belt development program, requested that additional impact tests of the Frost buckle be accomplished using adjusters supplied by East/West Industries, Incorporated, and H. Koch & Sons. This report documents the resulting impact test program and its results.

B. OBJECTIVES

The primary objective of the test program was to evaluate the adequacy of HBU-X lap belt prototypes with alternative belt adjusters under 40 G impact conditions. The secondary objective of the test program was to evaluate the influence of webbing materials on lap belt structural adequacy and adjuster performance.

C. EVALUATION CRITERIA

The adequacy of the lap belt prototypes was evaluated on the basis of the following criteria:

a. The lap belt and its components shall withstand without failure the loads developed during a 40 G impact with a 95th percentile size anthropomorphic dummy.

b. Webbing slippage through any lap belt adjuster shall not exceed more than one-half inch.

c. The lap belt buckle shall be manually releasable after the impact test.

SECTION 2

TEST METHODS

A. FACILITIES AND PROCEDURES

The impact tests were performed using a horizontal impact facility, the AFAMRL Impulse Accelerator (Shaffer, 1976). The facility consists of a gas-operated actuator, a test sled, and track rails as shown in Figure 1. The planned acceleration level to be produced by the facility actuator was 40 G with an impact velocity of 106 ft/sec.

The restraint systems were mounted on a generic seat that was designed incorporating seat geometry in accordance with MIL-S-9479B. The seat back angle was 13 degrees aft of vertical, and the seat pan was inclined 6 degrees above the horizontal. The seat and test sled are shown in Figure 2.

The anthropomorphic dummy that was used in the tests was a Type C-95 manufactured by Alderson Research Laboratories, Inc. The dummy weighed 210 lb and was designed to approximate 95th percentile adult male USAF flying personnel weight, stature, and sitting height (NASA Ref. Pub. 1024, 1978). Prior to each test the dummy's joints were adjusted to a nominal one-G value in accordance with Federal Motor Vehicle Standard No. 208 (U.S. Department of Transportation, 1972).

The test dummy was seated in the generic seat and restrained by two shoulder straps and a lap belt. New harnesses were used for each test. In two tests a negative-G strap was used to anchor the lap belt to the seat structure. Prior to each test the lap belt and shoulder harness were preloaded to a force of 10 ± 2 lb measured at the shoulder harness and lap belt attachment points. After all adjustments to the restraint system were completed, each belt and shoulder harness strap was marked at the adjuster to allow measurement of belt slippage.

The first test was accomplished at a level of 32.8 G. Subsequent tests were accomplished at the 40 G level. The temperature of the laboratory area was maintained at 70 ± 5 degrees F. throughout the test program.

Measurements taken during the impact tests included impact sled acceleration and velocity, loads measured at the attachment points of the restraint harness, and displacement of targets mounted on the test dummy. The restraint harness was inspected for damage and belt slippage measurements were made immediately after each test. A functional test was also performed by the test conductor after each test to evaluate the operability of the lap belt buckle. Photographs were taken of all failed equipment after each test.

B. TEST ARTICLES

The HBU-X lap belt used in this test program is an automatic opening, adjustable safety belt for aircraft ejection seats. The automatic opening feature of the

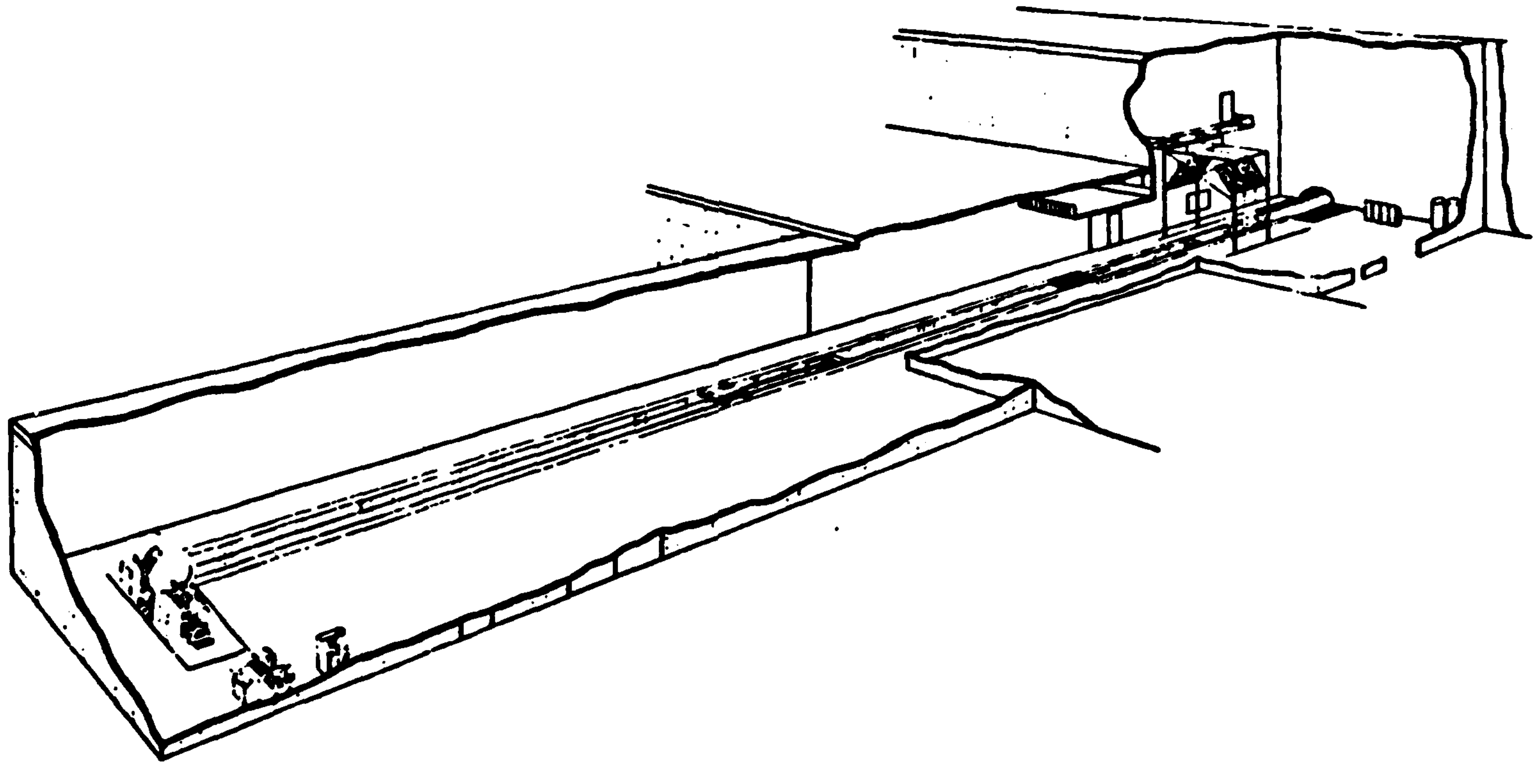

FIGURE 1. HORIZONTAL IMPULSE ACCELERATION FACILITY

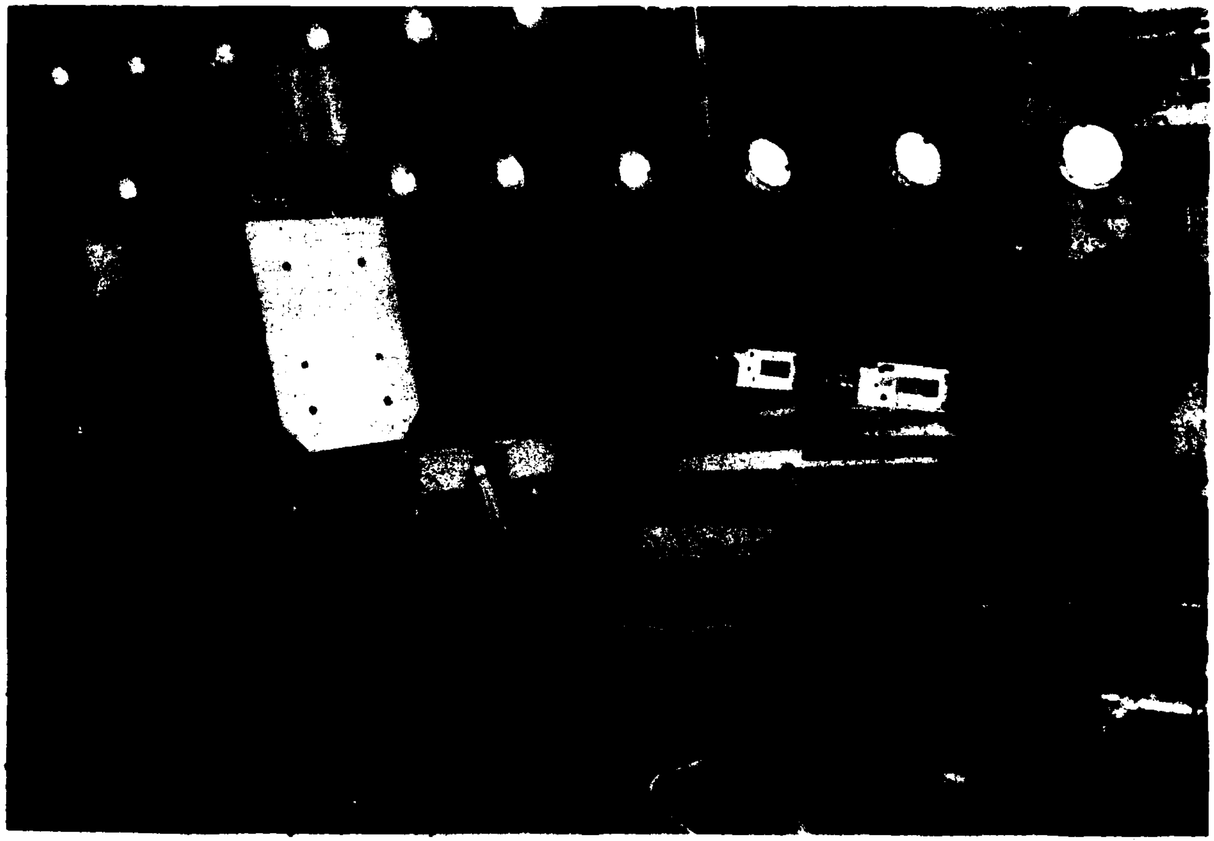

FIGURE 2. TEST SEAT AND SLED

belt is provided by a gas-activated mechanism that is an integral part of the buckle. The buckle assembly also incorporates a mechanism to provide manual opening and a connection for a gold key used for automatic parachute deployment. The belt consists of two double lengths of fabric webbing, two adjusters, and two seat-attachment anchors.

The HBU-X lap belt configurations tested consisted of seven different combinations of components. The component of primary interest was the belt webbing adjuster. Two types of adjusters were evaluated: an H. Koch and Sons Part No. 015-12231-3 adjuster (see Figure 3) and an East/West Industries, Incorporated, Part No. 184C100-1 adjuster (see Figure 4). The attachment anchors used to fasten the lap belt to the seat were fabricated in accordance with Frost Engineering Development Corporation Drawing No. 549035. Two types of webbing materials were used to study the influence of webbing material on the efficacy of the lap belt adjusters. These materials were 1 3/4-inch wide polyester webbing type III, class 1 (MIL-W-25361C) and 1 3/4-inch wide nylon webbing type XIII, class 1 (MIL-W-4088H). The final two tests were accomplished using 1 3/4-inch wide polyester webbing, type III, class 2, impregnated with latex rubber. For the majority of the tests, the lap belt buckle developed by the Frost Engineering Development Corporation (see Figure 5) was used. However, due to the limited number of Frost buckles available, HBU-2B/A buckles were used in five of the tests as shown in Figure 6.

The lap belts were tested as an integral part of a lap belt and shoulder harness configuration. The shoulder harness was an MB-6 harness (MIL-H-5364D) constructed of 1 3/4-inch wide type I polyester webbing (MIL-W-25361C).

The shoulder harness attaching link was designed in accordance with USAF Drawing No. 63B4009. A negative-G strap, Part No. 45402-0101649-01 constructed of 1 3/4-inch wide type I polyester webbing, was used in two tests.

C. ELECTRONIC DATA ACQUISITION SYSTEM

Both data acquisition and processing requirements were satisfied by utilizing the data acquisition system described in Appendix A. For this test program, data were taken using 14 channels. Electronic equipment mounted on the test sled was used to amplify, filter, and encode the data from all channels into a digital format (pulse-code modulated) which was then transmitted via an umbilical cable to a word formatter. The word formatter reformatted the serial data into parallel data which were then routed to a PDP-11/34 computer for storage and analysis.

Electronic data collected during the tests consisted of sled acceleration and velocity and harness loads. Sled acceleration was measured using three miniature piezoresistive accelerometers mounted to the structure of the sled. Velocity was computed from displacement data collected during the impact phase of the tests. The test fixture was instrumented to measure the restraint forces by using load cells at each of the restraint system attachment points. Detailed

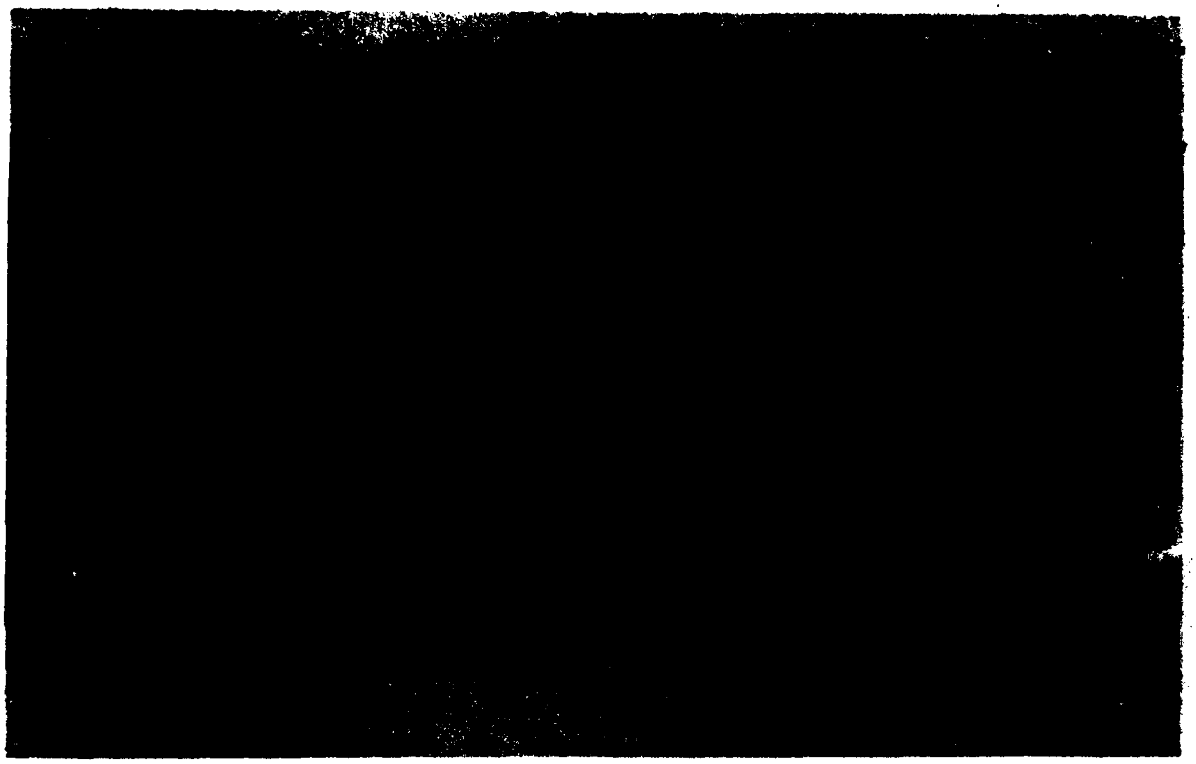

FIGURE 3. LAP BELT ADJUSTER MANUFACTURED BY H. KOCH AND SONS

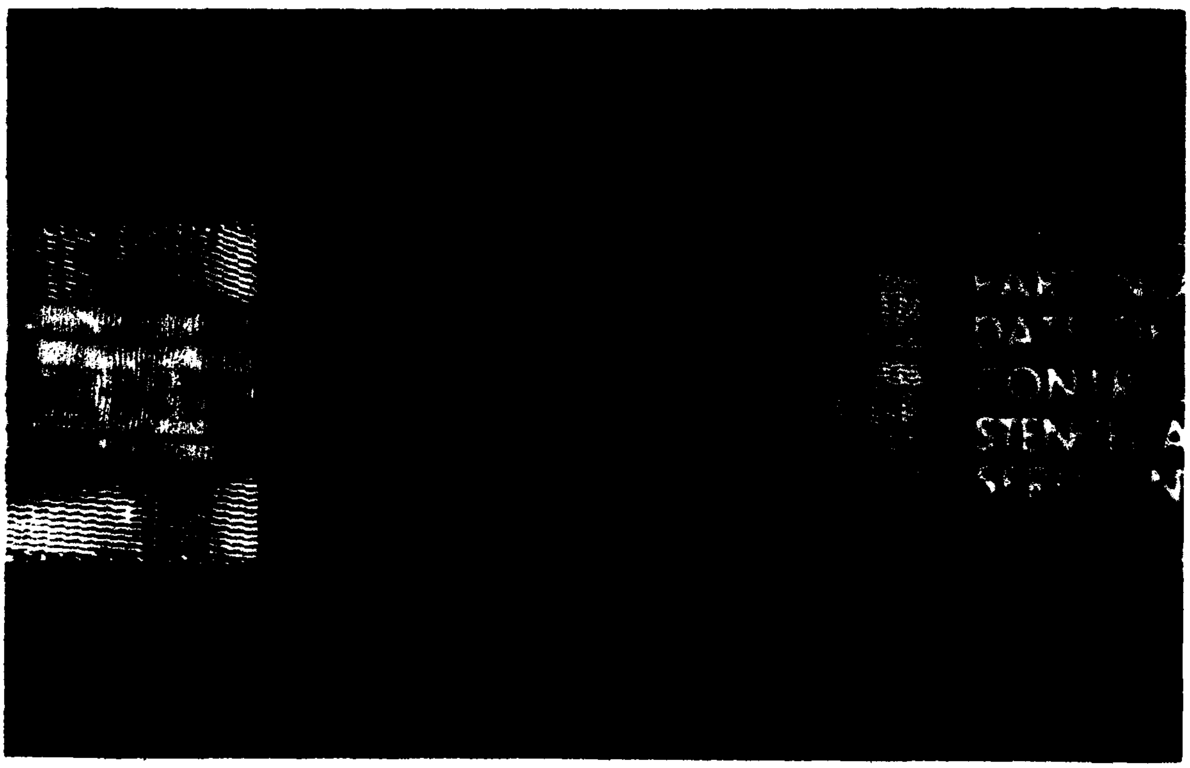

FIGURE 4. LAP BELT ADJUSTER MANUFACTURED BY EAST/WEST INDUSTRIES INCORPORATED

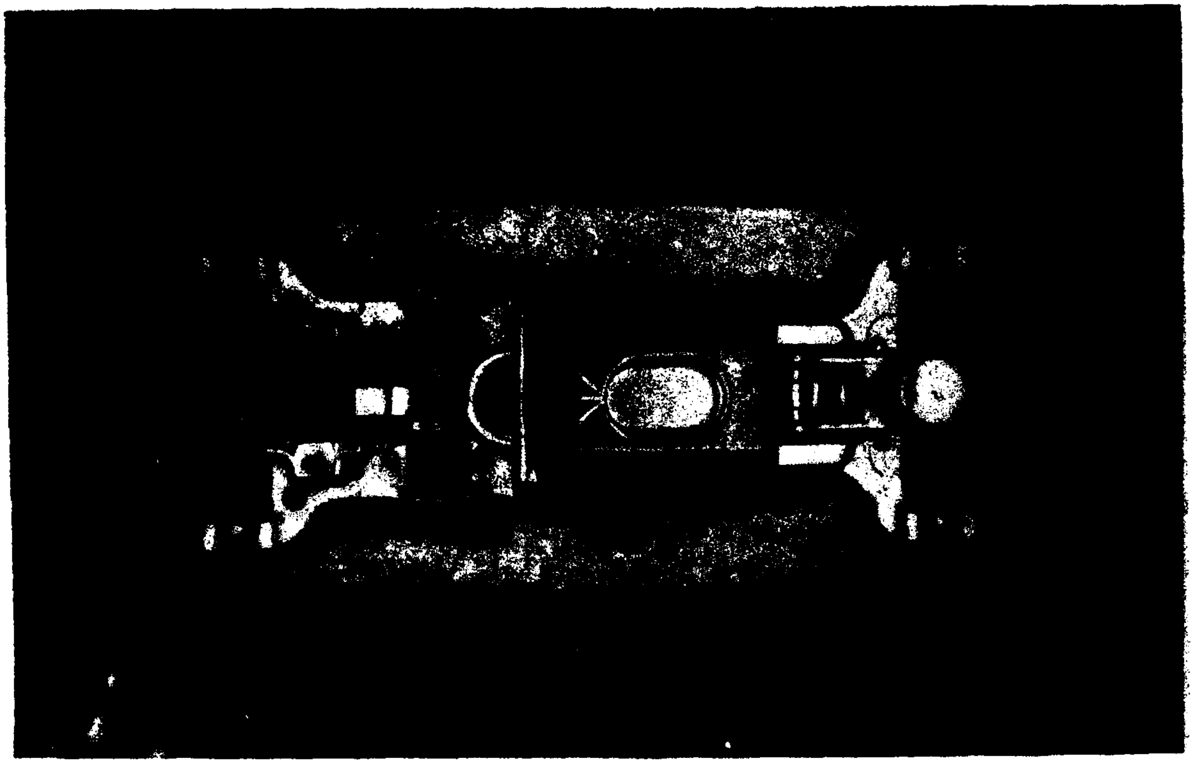

FIGURE 5. LAP BELT BUCKLE DEVELOPED BY
FROST ENGINEERING DEVELOPMENT CORPORATION

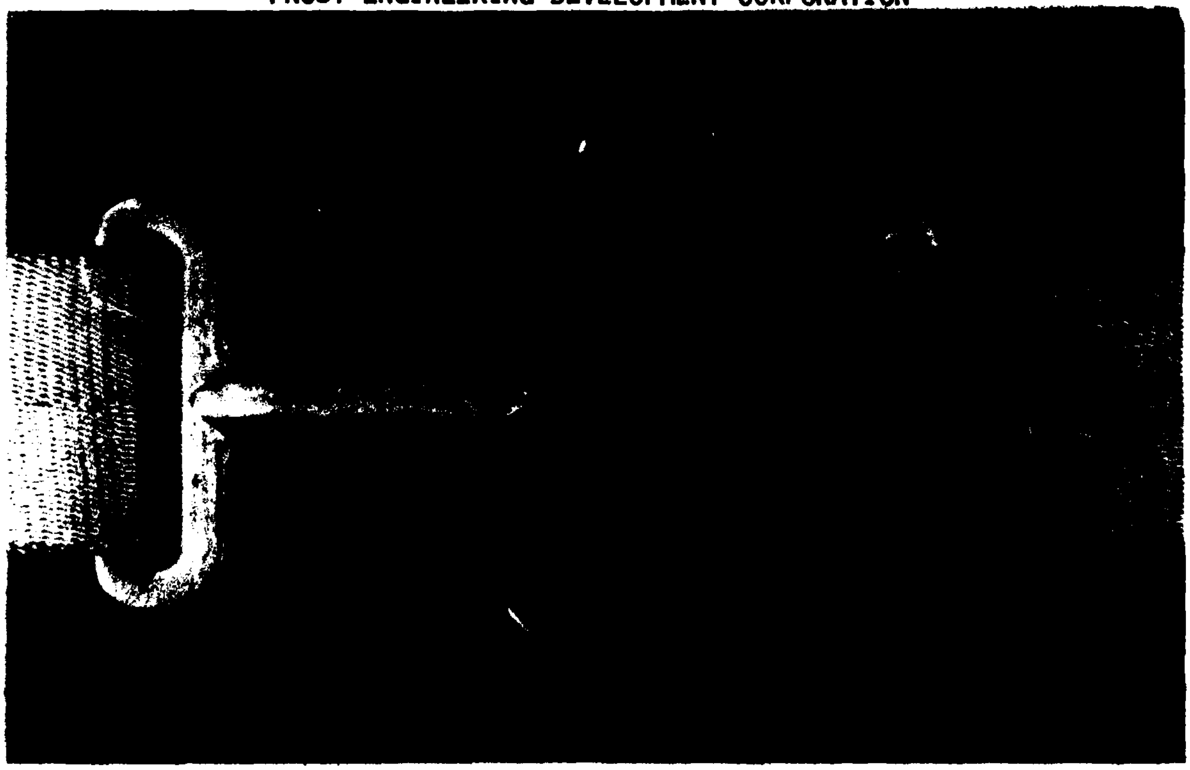

FIGURE 6. HBU-2B/A LAP BELT BUCKLE

descriptions of the instrumentation, electronic data processing equipment, mounting procedures, and calibration techniques are provided within Appendix A.

D. PHOTOGRAMMETRIC SYSTEM

Two motion-picture cameras (Photosonic Model 16mm-1B) were mounted on the sled to record the movement of the test dummy and to document any failure of the restraint system. One camera provided a side view of the seated dummy and the second camera was located to provide a front oblique view. Each camera was operated at 500 frames per second and was synchronized with the electronic data by a pulse code and an electronic flash.

A video camera was also used to document the tests. This camera and the recorder used with it are capable of recording motion at a rate of 120 frames/sec with an effective shutter speed of 10 microseconds or less. Use of this system allowed the investigators to evaluate the lap belt response to impact immediately after each test. This system is described in Appendix A.

E. DATA PROCESSING

Data from each test were reduced in a standardized format. Reduced electronic data are available for review within Appendix B. Computer summaries provide relevant maxima and minima from a total of 14 recorded signals. Relevant sums and times were also computed. The sums of the measured forces are the maximum values of continuously summed measurements. Scaled plots of selected signals and computed resultants were produced. Time integrals of sled acceleration signals were compared with velocity determined from displacement measurements.

SECTION 3

FINDINGS

A. TEST-BY-TEST NARRATIVES

Test 2021 - A test of a lap belt assembly including an HBU-2B/A buckle, polyester webbing, and Koch adjusters. The maximum sled acceleration was 32.8 G, the maximum sled velocity was 95.1 ft/sec, and the duration of the acceleration pulse was 143 milliseconds. The measured lap belt slip through each adjuster was less than ½ inch. The measured slip of the webbing through the shoulder harness adjusters was less than ½ inch.

Test 2022 - A test of a lap belt assembly including an HBU-2B/A buckle, polyester webbing, Koch adjusters, and a negative-G strap. The maximum sled acceleration was 40.2 G, the maximum sled velocity was 106 ft/sec, and the duration of the acceleration pulse was 128 milliseconds. The measured lap belt slip through the adjusters was 2 ½ inches on the left side and 1 inch on the right side. The measured slip of webbing through the shoulder harness adjusters was less than ½ inch.

Test 2025 - A test of a lap belt assembly including a Frost buckle, polyester webbing, and East/West adjusters. The maximum sled acceleration was 39.4 G, the maximum sled velocity was 105 ft/sec, and the duration of the acceleration pulse was 127 milliseconds. The measured lap belt slip was less than ½ inch. The measured webbing slip through the shoulder harness adjusters was less than ½ inch. The manual release of the buckle functioned satisfactorily after the acceleration test.

Test 2026 - A test of a lap belt assembly including a Frost buckle, polyester webbing, and Koch adjusters. The maximum sled acceleration was 40.0 G, the maximum sled velocity was 105 ft/sec, and the duration of the acceleration pulse was 129 milliseconds. The measured lap belt slip through the adjusters was 4 ½ inches on the right side and 2 3/4 inches on the left side. The measured slip of the webbing through the shoulder harness adjusters was less than ½ inch. The manual release of the buckle functioned satisfactorily after the acceleration test.

Test 2027 - A test of a lap belt assembly including a Frost buckle, polyester webbing, and East/West adjusters. The maximum sled acceleration was 39.8 G, the maximum sled velocity was 104 ft/sec, and the duration of the acceleration pulse was 130 milliseconds. The measured lap belt slip through the adjusters was less than ½ inch. The measured slip of webbing through the shoulder harness adjusters was less than ½ inch. The manual release of the buckle functioned satisfactorily after the acceleration test.

Test 2028 - A test of a lap belt assembly including a Frost buckle, polyester webbing, and Koch adjusters. The maximum sled acceleration was 40.4 G, the

maximum sled velocity was 106 ft/sec, and the duration of the acceleration pulse was 127 milliseconds. The measured lap belt slip through the adjusters was 2 ¼ inches on the right side and less than ½ inch on the left side. The measured slip of webbing through the shoulder harness adjusters was less than ½ inch. The manual release of the buckle functioned satisfactorily after the acceleration test.

Test 2029 - A test of a lap belt assembly including a Frost buckle, polyester webbing, East/West adjusters, and a negative-G strap. The maximum sled acceleration was 40.1 G, the maximum sled velocity was 106 ft/sec, and the duration of the acceleration pulse was 128 milliseconds. The measured lap belt slip through the adjusters was less than ½ inch. The measured webbing slip through the shoulder harness adjusters was less than ½ inch. The manual release of the buckle functioned satisfactorily after the acceleration test.

Test 2030 - A test of a lap belt assembly including a Frost buckle, polyester webbing, and Koch adjusters. The maximum sled acceleration was 39.6 G, the maximum sled velocity was 106 ft/sec, and the duration of the acceleration pulse was 126 milliseconds. The measured lap belt slip through the adjuster was 4 3/4 inches on the right side and less than ½ inch on the left side. The measured webbing slip through the shoulder harness adjusters was less than ½ inch. The manual release of the buckle functioned satisfactorily after the acceleration test.

Test 2031 - A test of a lap belt including an HBU-2B/A buckle, polyester webbing, and Koch adjusters. The maximum sled acceleration was 39.7 G, the maximum sled velocity was 105 ft/sec, and the duration of the acceleration pulse was 129 milliseconds. The measured lap belt slip through the adjusters was 2 3/4 inches on the left side and less than ½ inch on the right side. The measured webbing slip through the shoulder harness adjusters was less than ½ inch.

Test 2080 - A test of a lap belt assembly constructed of nylon webbing, Frost buckle, and East/West adjusters. The maximum sled acceleration was 40.2 G, the maximum sled velocity was 107 ft/sec, and the duration of the acceleration pulse was 121 milliseconds. The measured lap belt slip through the adjusters was ½ inch on the left side. The right side of the lap belt retracted 5/8 inch into the adjuster. The measured slip of the webbing through the shoulder harness adjusters was 1 ¼ inch on the right side and 1 7/8 inch on the left side. The shoulder harness attaching link failed at its point of attachment to the shoulder harness load cell clevis as shown in Figure 7. The peak load measured at this attachment was 4549 lb. The lap belt material then failed near its point of attachment to the belt buckle. The buckle automatic disconnect mechanism failed after the lap belt failed. The failure of the automatic disconnect mechanism was apparently caused by the shoulder harness that was still attached to the dummy's neck. The sequence of failure was substantiated by electronic and photogrammetric data.

FIGURE 7. PHOTOGRAPH OF THE SHOULDER HARNESS ATTACHMENT LINK FAILURE, TEST 2080

Test 2081 - A test of a lap belt assembly including nylon webbing, a Frost buckle, and Koch adjusters. The maximum sled acceleration ws 40.6 G, the maximum sled velocity was 106 ft/sec, and the duration of the acceleration pulse was 126 milliseconds. The measured lap belt slip through the adjusters was 14 ½ inches on the left side and 3 ¼ inches on the right side. The shoulder harness webbing slipped through the adjusters 5/8 inch on the left side and less than ½ inch on the right side. The shoulder harness attaching link failed at its point of attachment to the shoulder harness load cell clevis. The shoulder harness load measured at the instant of failure was 4395 lb. The lap belt failed at its point of attachment to the lap belt buckle after the shoulder harness failed.

Test 2082 - A test of a lap belt assembly including a Frost buckle, nylon webbing, and East/West adjusters. The maximum sled acceleration was 38.9 G, the maximum sled velocity was 105 ft/sec, and the duration of the acceleration pulse was 128 milliseconds. The measured lap belt slip through the adjusters was less than ½ inch. The measured slip of the webbing through the shoulder harness adjusters was less than ½ inch. The manual release of the buckle functioned satisfactorily after the acceleration test.

Test 2083 - A test of a lap belt assembly including nylon webbing, a Frost buckle, and Koch adjusters. The maximum sled acceleration was 42.9 G, the maximum sled velocity was 108 ft/sec, and the duration of the acceleration pulse was 126 milliseconds. The measured lap belt slip through the adjusters was less than ½ inch. The buckle automatic disconnect mechanism failed. This mechanism includes a release plug that retains the link tongue of the buckle to the automatic disconnect body. The plug was pulled over the lip of its socket in the disconnect body. The loads that were measured at the right and left lap belt attachments were 3321 lb and 3740 lb, respectively. The higher-than-planned acceleration measured during this test was attributed to the release of mass of the test dummy from the total accelerated mass of the sled resulting from the restraint system failure.

Test 2084 - A test of a lap belt assembly including nylon webbing, a Frost buckle, and Koch adjusters. The maximum sled acceleration was 39.5 G, the maximum sled velocity was 105 ft/sec, and the duration of the acceleration pulse was 126 milliseconds. The lap belt slipped through the adjusters 1 ½ inches on the left side and less than ½ inch on the right side. The measured webbing slip through the shoulder harness adjusters was less than ½ inch. The manual release of the buckle functioned satisfactorily after the acceleration test.

Test 2087 - A test of a lap belt assembly including latex-impregnated polyester webbing, an HBU-2B/A buckle, and East/West adjusters. The maximum sled acceleration was 40.4 G, the maximum sled velocity was 105 ft/sec, and the duration of the acceleration pulse was 126 milliseconds. The measured lap belt slip through the adjusters was less than ½ inch. The measured slip of webbing through the shoulder harness adjusters was less than ½ inch.

Test 2088 - A test of a lap belt assembly including latex-impregnated polyester webbing, an HBU-2B/A buckle, and Koch adjusters. The maximum sled acceleration

was 40.6 G, the maximum sled velocity was 106 ft/sec, and the duration of the acceleration pulse was 127 milliseconds. Both sides of the lap belt slipped completely through the adjusters. The measured slip of webbing through the shoulder harness adjusters was less than ½ inch.

B. SUMMARY OF DATA

The results of the tests accomplished during this program are summarized in tables I and II. The detailed data from the sixteen tests accomplished during this program are provided in Appendix B.

TABLE I. SUMMARY OF TEST RESULTS

TEST NO.	PEAK G	BUCKLE TYPE	ADJUSTED TYPE	WEBBING TYPE	TEST OUTCOME	REMARKS
2021	32.8	HBU-2B/A	Koch	Polyester	Success	
2022	40.2	HBU-2B/A	Koch	Polyester	Failure	Belt slippage
2025	39.4	Frost	East/West	Polyester	Success	
2026	40.0	Frost	Koch	Polyester	Failure	Belt slippage
2027	39.8	Frost	East/West	Polyester	Success	
2028	40.4	Frost	Koch	Polyester	Failure	Belt slippage
2029	40.1	Frost	East/West	Polyester	Success	
2030	39.6	Frost	Koch	Polyester	Failure	Belt slippage
2031	39.7	HBU-2B/A	Koch	Polyester	Failure	Belt slippage
2080	40.2	Frost	East/West	Nylon	Failure	Shoulder harness failed; Auto disconnect failed
2081	40.6	Frost	Koch	Nylon	Failure	Shoulder harness failed
2082	38.9	Frost	East/West	Nylon	Success	
2083	42.9	Frost	Koch	Nylon	Failure	Auto disconnect failed
2084	39.5	Frost	Koch	Nylon	Failure	Belt slippage
2087	40.4	HBU-2B/A	East/West	Polyester*	Success	
2088	40.6	HBU-2B/A	Koch	Polyester*	Failure	Belt slippage

*Latex Impregnated

TABLE II. MAXIMUM HARNESS LOADS

TEST NO.	PEAK G	SHOULDER STRAP LOAD (LB)	RT LAP BELT LOAD (LB)	LF LAP BELT LOAD (LB)	NEG-G STRAP LOAD (LB)	REMARKS
2021	32.8	3941	3571	3472	NA	Success
2022	40.2	4532	3829	3777	267	Belt slip
2025	39.4	4453	4847	4555	NA	Success
2026	40.0	4455	4152	4119	NA	Belt slip
2027	39.8	4593	4244	4362	NA	Success
2028	40.4	4317	4205	4064	NA	Belt slip
2029	40.1	4642	4389	4367	193	Success
2030	39.6	4314	3486	3891	NA	Belt slip
2031	39.7	4207	4370	3772	NA	Belt slip
2080	40.2	4549	5666	6095	NA	Shoulder harness failed
2081	40.6	4395	4581	5326	NA	Shoulder harness failed
2082	38.9	4530	4846	4832	NA	Success
2083	42.9	4432	3321	3740	NA	Auto disconnect failed
2084	39.5	4482	3901	4059	NA	Belt slip
2087	40.4	4513	3878	4497	NA	Success
2088	40.6	4283	3484	3535	NA	Belt slip

NA = not applicable

SECTION 4

DISCUSSION

A. ADJUSTER TEST RESULTS

Six tests were accomplished using the East/West adjusters in combination with nylon, polyester, or latex-impregnated polyester webbing, and the Frost or HBU-2B/A buckles. Five of these tests--2025, 2027, 2029, 2082, and 2087--were judged to be successful since the restraint systems did not structurally fail and the adjusters limited the lap belt slippage to ½ inch or less. Test 2080 was not considered to be an adequate test of the lap belt assembly because the shoulder harness failed. There was no evidence to conclude that the East/West adjusters were at fault in this test since the lap belt slippage was within the ½-inch allowable slippage. Slippage of the shoulder harness adjusters may have contributed to the failure of the shoulder harness attaching link, but the shoulder harness load-time history does not support this contention.

Ten tests were accomplished using the Koch adjusters in combination with nylon, polyester, or latex-impregnated polyester webbing, and the Frost or HBU-2B/A buckles. Test 2021 was judged to be an inadequate test of the lap belt and adjusters since the acceleration was limited to 32 G. Tests 2022, 2026, 2028, 2030, 2031, 2084, and 2088 were judged to be failures of the Koch adjusters due to lap belt slippage. The belt slippage measured in these seven tests ranged from 1 ½ to 14 ½ inches. In Test 2088 the lap belt slipped completely through both adjusters. Test 2081 was considered to be an inadequate test of the lap belt adjusters since the shoulder harness failed. Test 2083 was judged to be an inadequate test of the lap belt adjusters since the lap belt buckle automatic release mechanism failed very early in the acceleration pulse.

B. SHOULDER HARNESS ATTACHMENT LINK FAILURES

The shoulder harness failures during tests 2080 and 2081 consisted of tear-out of the material surrounding the 7/64-inch diameter attachment hole of the attaching link (USAF Drawing No. 63B4009) of the MB-6 shoulder harness. This type of failure is shown in Figure 7. The peak shoulder harness load measured during Test 2080 was 4395 lb and 4530 lb during Test 2081. Tensile tests conducted subsequently with other samples of the attaching link failed at 5180 and 5300 lb. Rockwell hardness tests of the failed attaching links indicated that they exceeded the minimum hardness specified by USAF Drawing No. 63B4009. Other factors that may have contributed to the failure of the attaching links include slippage of the lap belt and shoulder harness adjusters. Lap belt slippage was within acceptable limits on Test 2080, but the shoulder straps slipped 1 7/8 inch on the left side and 1 ¼ on the right side. In Test 2081 slippage of the shoulder straps was 5/8 inch on the left side and ½ inch on the right side, and the lap belt slippage was 14 ½ inches on the left side and 3 ¼ inches on the right side. However, it was not possible to determine how much of the lap belt slippage occurred before the attaching link failure.

C. AUTOMATIC DISCONNECT FAILURES

The failures of the automatic disconnect mechanism of the Frost buckle seen in tests 2080 and 2083 have been evaluated by the Frost Engineering Development Corporation for the Life Support Systems Program Office under Contract F33657-81-C-0104 (Frost, 1983). The Frost evaluation report points out that the loads encountered during the 40 G impact tests were close to the originally specified 4500-lb ultimate strength of the buckle hardware (Specification 412A-07878-55016). The report also emphasizes that the absence of a negative-G strap creates a much more severe combined-loading condition than was required by the original development specification. The loading conditions of the development specification were predicated on a negative-G strap and shoulder harness always being installed and thus counterbalancing each other across the link tongue of the buckle. The Frost report contends that when there is no negative-G strap to counterbalance the shoulder-harness load, the shoulder harness and lap belt loads cause the manual release and the automatic disconnect assemblies of the buckle to pivot downward at their respective ends and the shoulder harness twists the link tongue upward relative to these assemblies. The net effect is to add significant side-load components to the original loads that governed the design of the manual release and the release plug of the automatic disconnect. Thus, the Frost report concludes, these loads caused the release plug in the automatic disconnect assembly to be pulled over the lip of its socket.

D. STATIC VERSUS DYNAMIC LOADS

The HBU-X lap belt development specification static load conditions were apparently based on the presumption that the maximum loads that will be applied to the belt buckle during the 40 G impact test are opposing forces of 2880 lb from each side of the lap belt and opposing forces of 3600 lb from the shoulder straps and negative-G strap. Review of the data collected during the test program described within this report shows that the measured dynamic loads are considerably greater than the static loads described by the specification. The maximum loads measured at the seat attachment points of the shoulder harness, lap belts, and negative-G strap are summarized in Table II. The highest shoulder strap load measured was 4642 lb in test 2029, a successful test. The highest lap belt load measured in any test was 6095 lb in Test 2080 at the instant of lap belt failure (This failure was secondary to shoulder harness failure.). The maximum lap belt load measured in a test without structural failure was 4847 lb (Test 2025). The maximum load measured in the negative-G strap was 267 lb (Test 2022).

The proportion of load carried by the negative-G strap in these tests is much lower than would be expected on the basis of data collected during tests of this restraint configuration conducted with human subjects (Hearon et al., 1983). On the basis of the human test data, the investigators would expect the negative-G strap load to be approximately five times higher than the maximum value measured during this test program.

E. NYLON WEBBING TEST RESULTS

Five tests were conducted using lap belt assemblies fitted with nylon webbing. One of the five tests, Test 2082, was judged to be successful. The successful test was accomplished using East/West adjusters and the Frost buckle. Three of the tests were not considered to be valid tests of the adjusters in combination with nylon webbing since either the shoulder harness attachment link or the lap belt buckle automatic disconnect mechanism failed. One test with the Koch adjusters in combination with nylon webbing was considered to be a valid test, but the adjuster mounted on the left side of the lap belt allowed the webbing to slip 1 ½ inches.

The tests where nylon webbing was used were insufficient in number to draw general conclusions regarding the influence of the nylon webbing on adjuster slippage tendency or restraint-harness load levels. However, the load levels would not be expected to be significantly different since the stress-strain characteristics of type III polyester webbing and type XIII nylon webbing are similar (Phillips et al., 1982).

SECTION 5

CONCLUSIONS AND RECOMMENDATIONS

The impact tests that were performed demonstrated that the adjusters manufactured by East/West Industries, Incorporated (Part No. 184C100-1) could sucessfully withstand the lap belt loads imposed during a 40 G impact test with a 95th percentile anthropomorphic dummy.

The East/West adjuster permitted no more than the one-half inch slippage of webbing under 40 G loads regardless of the type of webbing material used in the HBU-X lap belt configuration.

The 40 G impact tests of the adjuster manufactured by H. Koch and Sons (P/N 015-12231-3) demonstrated that the adjuster allows slippage of the HBU-X lap belt webbing beyond acceptable limits.

The Koch adjuster performance did not appear to be influenced by the type of webbing material that was used in the HBU-X lap belt configuration.

The shoulder harness attachment link (USAF Drawing No. 63B4009) of the MB-6 shoulder is inadequate to withstand 40 G impact tests with a 95th percentile dummy. Engineering analysis and redesign of the attachment link are recommended on the basis of the harness load data within this report.

A failure mode of the HBU-X lap belt buckle automatic disconnect mechanism was discovered which appears to be related to the unanticipated direction and magnitude of the loads applied to the buckle during the impact tests. The buckle was designed in accordance with a developmental specification that presumed a negative-G strap would always be used with the buckle. The negative-G strap would counterbalance the shoulder harness loads. Since the HBU-X lap belt may be used operationally without the negative-G strap, the presumption is incorrect and leads to unrealistic design-load assumptions. (Note: Redesign of the automatic release mechanism of the buckle has been accomplished.)

The directions and magnitudes of static loads applied to the HBU-X buckle as specified in the developmental specification are not representative of the directions and magnitude of loads applied to the buckle during 40 G impact tests.

The load carried by the negative-G strap during the 40 G impact tests with dummy subjects is considerably lower than would be predicted from 10 G tests of the same harness configuration with human subjects.

The design and test load conditions of the lap belt specification should be revised to reflect the findings of this experimental test program and previous impact tests conducted with human subjects.

Insufficient numbers of tests were conducted to evaluate the influence of nylon or polyester webbing material or webbing treatment on lap belt loads.

APPENDIX A

DATA ACQUISITION SYSTEM

A. INSTRUMENTATION

Data collected during the HBU-X lap belt test program consisted of impact sled acceleration, velocity and restraint harness loads. Sled acceleration was measured using three miniature piezoresistive accelerometers mounted to the sled structure. Loads in the restraint systems were measured by load cells mounted to the restraint harness attachment fittings. The measurement transducers used in the test program are listed in Table A-1, which designates the manufacturer, type, serial number, sensitivity and other specifications of each transducer utilized. Table A-2 provides specifications for test event data, channel bias voltage, and transducer excitation voltage. The instrumentation coordinate system and the locations of the load cells in the x, y, and z axes are shown in Figure A-1.

The three accelerometers were positioned to measure the acceleration of the sled in the x, y, and z axis. The package consisted of two Endevco Model 2264 and one Endevco Model 2262 accelerometers mounted to a 3/4 x 1 x 1 inch aluminum block which was mounted to the undersurface of the sled.

Pre-program and post-program calibrations were made to check the accuracy of the data-measuring transducers. The calibration of the accelerometers was performed by the Dynalectron Corporation using the reciprocity method (Ensor, 1970). A laboratory standard accelerometer, calibrated on a yearly basis by Endevco with standards traceable to the National Bureau of Standards, and a test accelerometer were mounted on a shake table. The frequency response and phase shift of the test accelerometer were determined by driving the shake table with a random noise generator and analyzing the outputs of the accelerometers with a PDP 11/15 minicomputer and 1923 Time Data Unit using Fourier analysis. The natural frequency and damping factor of the test accelerometers were determined, recorded, and compared to previous calibration data for that test accelerometer. Calibrations were made at a frequency of 100 Hz and acceleration of 40 G. The sensitivity of the test accelerometer was determined by comparing its output to the output of the laboratory standard accelerometer.

The negative-G strap was attached to a Strainsert load cell. The calibration of the Strainsert load cell was performed by the Precision Measurement Equipment Laboratory (PMEL), Wright-Patterson Air Force Base. PMEL calibrated this load cell on a periodic basis and provided current sensitivity and linearity data.

Three triaxial GM load cells were used to measure the shoulder strap load and the right and left lap belt loads. These load cells were calibrated to a laboratory standard load cell in a special test fixture by the Dynalectron Corporation. The sensitivity and linearity of each load cell were obtained by comparing the output of the test load cell to the output of the laboratory

DIGITAL INSTRUMENTATION REQUIREMENTS

DYNALECTRON CORPORATION

PROGRAM: HBUX LAP BELTS DATE: 5 JAN 82 THRU: * 17 FEB 82

FACILITY: HORIZONTAL IMPULSE ACCELERATOR RUN: 2020 THRU: * 2088

DATA CHANNEL	DATA POINT	XDUCER MFG & TYPE	S/N	XDUCER SENS	EXCITE V	EXCITE CHAN	FILTER SERIES	FILTER S/N	AMP GAIN	AMP S/N	SAMPLE RATE	SAMPLE FORMAT	F.S. SENS	FILTER HZ	XDUCER ZERO	XDUCER RANGE	BRIDGE BALANCE RESISTORS	BRIDGE COMPLETION RESISTORS	SPECIAL NOTATIONS
1	SLED X	ENDEVCO 2262A-200	FM42	4.138 mv/g	10.00	1	60	1	10	2	1K	1	60.4g	120	2.5	+5.0 -0.0	375K -IN TO GND	-	
2	SLED Y	ENDEVCO 2264-200	BM92	2.385 mv/g	10.00	2	60	2	50	5	1K	1	21.0g	120	2.5	+5.0 -0.0	100K -IN TO GND	1.63K	
3	SLED Z	*	BX48	2.653 mv/g	10.00	3	60	3	50	26	1K	1	18.8g	120	2.5	+5.0 -0.0	254K -IN TO GND	*	
15	LEFT LAP LOAD X	GN 3D-SW	15X	5.04 uv/LB	10.00	15	60	15	100	19	1K	1	4960LB	120	2.5	+5.0 -0.0	50K +IN TO GND	-	
16	LEFT LAP LOAD Y	*	15Y	5.30 uv/LB	10.00	16	60	16	201	1	1K	1	2347LB	120	2.5	+5.0 -0.0	13.7K +IN TO GND	-	
17	LEFT LAP LOAD Z	*	15Z	6.24 uv/LB	10.00	17	60	17	100	5	1K	1	4006LB	120	2.5	+5.0 -0.0	15K +IN TO GND	-	
18	RIGHT LAP LOAD X	*	21X	4.95 uv/LB	10.00	18	60	18	100	16	1K	1	5051LB	120	2.5	+5.0 -0.0	13.5K +IN TO GND	-	
19	RIGHT LAP LOAD Y	*	21Y	4.90 uv/LB	10.00	19	60	19	201	8	1K	1	2538LB	120	2.5	+5.0 -0.0	17.3K +IN TO GND	-	
20	RIGHT LAP LOAD Z	*	21Z	6.06 uv/LB	10.00	20	60	20	100	31	1K	1	4125LB	120	2.5	+5.0 -0.0	90K -IN TO GND	-	
21	SHOULDER LOAD Z	*	20X	5.11 uv/LB	10.00	21	60	21	201	9	1K	1	2434LB	120	2.5	+5.0 -0.0	160K +IN TO GND	-	USE LOAD CELL X AXIS CAL.
22	SHOULDER LOAD Y	*	20Y	5.46 uv/LB	10.00	22	60	22	402	13	1K	1	1139LB	120	2.5	+5.0 -0.0	800K +IN TO GND	-	
23	SHOULDER LOAD X	*	20Z	6.29 uv/LB	10.00	23	60	23	100	2	1K	1	3975LB	120	.40	+5.0 -0.0	52K -IN TO GND	-	
29	VELOCITY	GLOBE 22A672	2	.2664 VOLTS FPS 10.25" WHEEL	10.00	29	60	29	1	-	1K	1	117.2 FPS	120	2.5	+5.0 -0.0	-	-	6.242 ATTENUATOR LOCATED IN SIG. COND. SENS. ÷ .2664 VOLTS FPS = .04253 V/FPS ATTEN. 6.242 POSITIVE OUTPUT
30	N-G STRAP	STRAINSERT FL1U-2SG	207	19.81 uv/LB	10.00	30	60	30	100	21	1K	1	1262LB	120	2.5	+5.0 -0.0	-	-	USED FOLLOWING TESTS: 2022,2024,2029

COMPUTER START: -6 SEC.
STOP: +4 SEC.

* NOTE: THE FOLLOWING TESTS CONDUCTED DURING PERIODS INDICATED 2020 THRU 2033, 5 JAN 82 THRU 15 JAN 82 2080 THRU 2088, 9 FEB 82 THRU 17 FEB 82

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Table A-1. Instrumentation Transducers and Channel Specifications.

DYNALECTRON CORPORATION

DIGITAL INSTRUMENTATION REQUIREMENTS

PROGRAM HBUK LAP BELTS DATE 5 JAN 82 THRU 15 JAN 82

FACILITY HORIZONTAL IMPULSE ACCELERATOR RUN 2020 THRU 2033

DATA CHANNEL	DATA POINT	XDUCER MFG & TYPE	S/N	XDUCER SENS	EXCITE V	CHAN	FILTER SERIES	S/N	AMP GAIN	S/N	SAMPLE RATE	FORMAT	F.S. SENS	FILTER HZ	XDUCER ZERO	RANGE	BRIDGE BALANCE RESISTORS	BRIDGE COMPLETION RESISTORS	SPECIAL NOTATIONS
37	EVENT	-	-	-	-	37	1000	30	2.5	9	1K	1	2.5 VOLT	2000	2.5	+5.0 -0.0	-	-	EVENT IS NEG. PULSE
47	2.5V BIAS	-	-	-	-	47	180	14	1	-	1K	1	2.5 VOLT	360	2.5	+5.0 -0.0	-	-	
48	10V.EXC.	-	-	-	10.00	48	180	27	1	-	1K	1	5.0 VOLT	360	5.0	+5.0 -0.0	-	-	

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Table A-2. Instrumentation Specifications for Test Event Data, Channel Bias Voltage, and Transducer Excitation Voltage.

HBU-X	Point No.	Axis X	Inches (Centimeters) Y	Z
Center Reference	1	0	0	0
* Load Cell	2	+15.06 (+38.1)	0	-1.56 (-3.96)
Triaxial Load Cell	3	0	+9.00 (+22.86)	-1.77 (-4.50)
Triaxial Load Cell	4	0	-9.00 (-22.86)	-1.77 (-4.50)
Triaxial Load Cell	5	-11.83 (-30.00)	0	+26.76 (+68.00)

* ROTATING IN XZ PLANE

<u>LOAD CELL 2</u> PROVIDES A POSITIVE (+) OUTPUT VOLTAGE WHEN THE N-G STRAP IS PULLED IN THE +Z DIRECTION.

<u>TRIAXIAL LOAD CELL 5</u> PROVIDES A POSITIVE (+) OUTPUT VOLTAGE FOR X, Y AND Z WHEN THE HARNESS IS PULLED IN THE +X, -Y AND -Z DIRECTIONS RESPECTIVELY.

<u>TRIAXIAL LOAD CELLS 3, 4</u> PROVIDE A POSITIVE (+) OUTPUT VOLTAGE WHEN THE HARNESS IS PULLED TOWARDS THE CENTER REFERENCE.

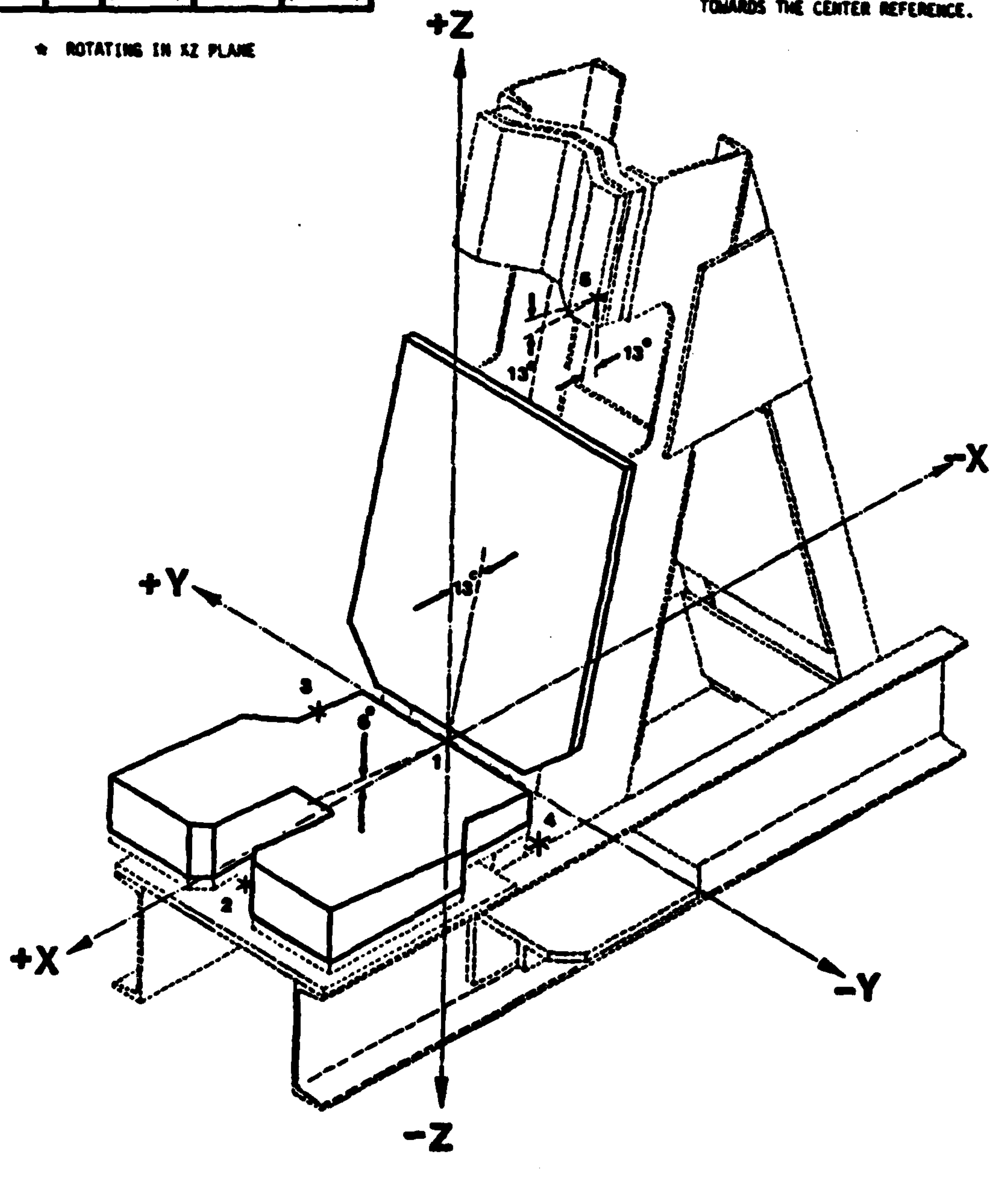


Figure A-1. Test Seat and Coordinate System.

standard under identical loading conditions. The laboratory standard load cell, in turn, is calibrated by PMEL on a periodic basis.

A Globe Industries tachometer, mounted in a special fixture, was used to measure sled velocity. The fixture consisted of an aluminum wheel, with a rubber O ring around its circumference to assure good rail contact, that was attached to the rotor of the tachometer. The tachometer was calibrated by rotating the wheel at various revolutions per minute (RPM) and recording both the output voltage and the RPM. The sensitivity was dynamically checked out with a VS300 velocity measuring system manufactured by GHI Systems, Rancho Palos Verdes, California. The VS300 system consists of a timing unit and an optical sensor mounted near the track rails. As the sled travels along the track rails, a metal blade on the sled interrupts the optical sensor beam. The timing unit displays a time which may be correlated to a velocity.

B. AUTOMATIC DATA ACQUISITION AND CONTROL SYSTEM (ADACS)

The Automatic Data Acquisition and Control System (ADACS) is composed of 48 separate data channels and was designed by the Physical Science Laboratory of the University of New Mexico. The ADACS provides excitation, amplifier gains and filtering in addition to digitizing the analog signal from the transducers. This system, which is rigidly mounted to the sled, can transfer the digitized electronic data via a seven-wire whip cable to the digital computer interface.

The sled-mounted portion of the ADACS consists of three major components: the power conditioner, the signal conditioner, and the encoder. The configuration is outlined in Figure A-2. The power conditioner receives 28 VDC via the whip cable and provides six regulated voltages. The signal conditioner contains 48 modules capable of processing transducer data. Each module has an amplifier and filter section. Each amplifier can be programmed for one of seven gains by use of external gain plugs. Each filter can be programmed for one of four filter frequencies by use of external filter plugs.

Each module provides +5 and +10 VDC for transducer excitation and +2.5 VDC for output signal offset, if necessary. Bridge completion and balance resistors can be added to the module input connector, if necessary. The 48 module output signals are digitized via the pulse code modulation (PCM) encoder into 48 eleven-digit words. Two additional 11-bit synchronization (sync) words are added to the data frame. This 50-word data frame is then sampled at a rate of 1000 samples per second. Three synchronization pulse trains (bit sync, word sync, and frame sync) are added to the word frame and sent to the computer via the junction box and whip cable.

The PDP 11/34 minicomputer receives serial data from the ADACS. The serial data coming from the sled are converted to parallel data in the data formatter. The data formatter deposits data by direct memory access (DMA) into the computer memory via the buffered data channel where data are stored on disk temporarily to be later transferred to magnetic tape for permanent storage. The interrelationships among the data acquisition and storage equipment are shown in Figure A-3.

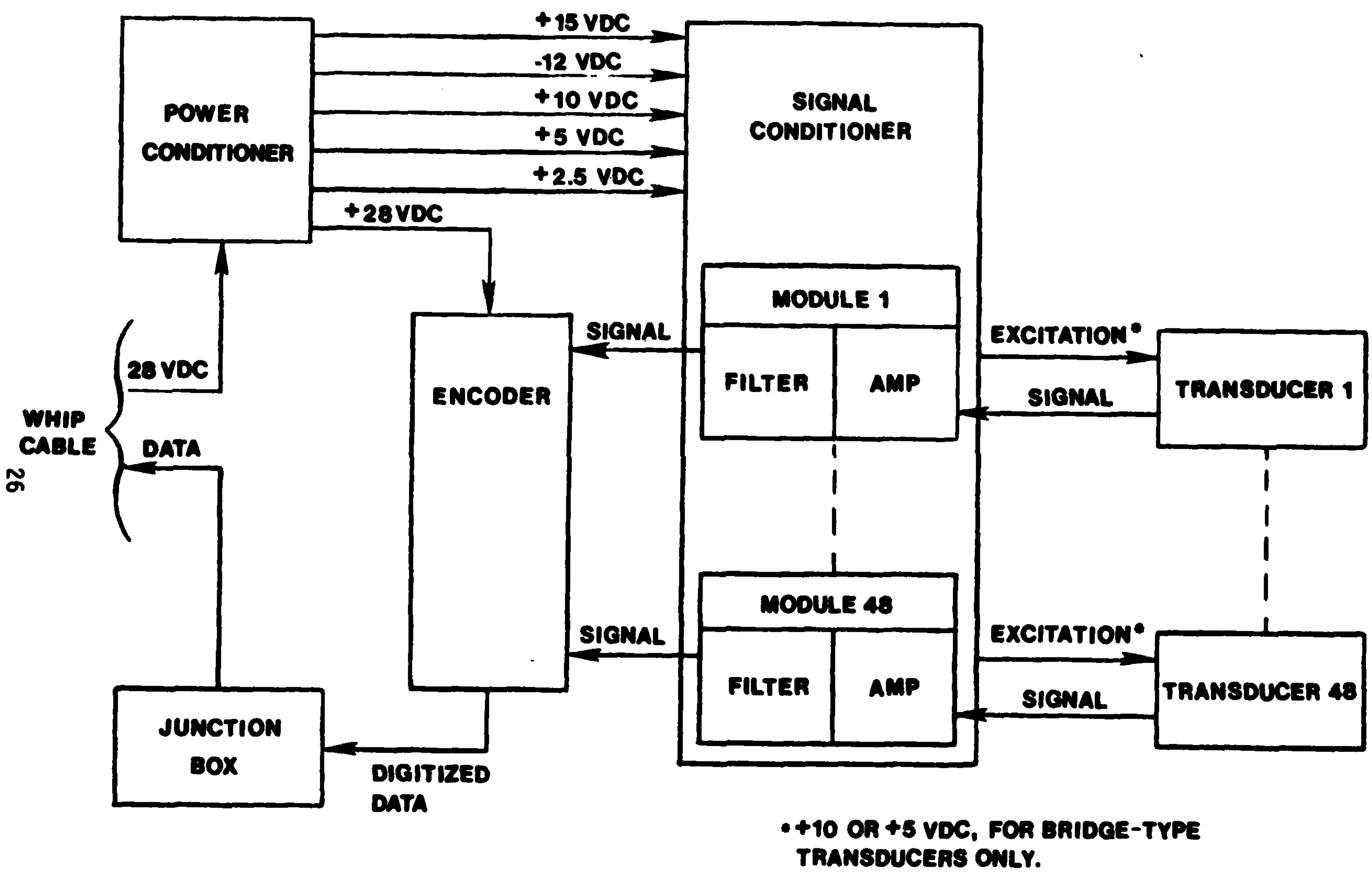


Figure A-2. Sled-Mounted Portion of the ADACS.

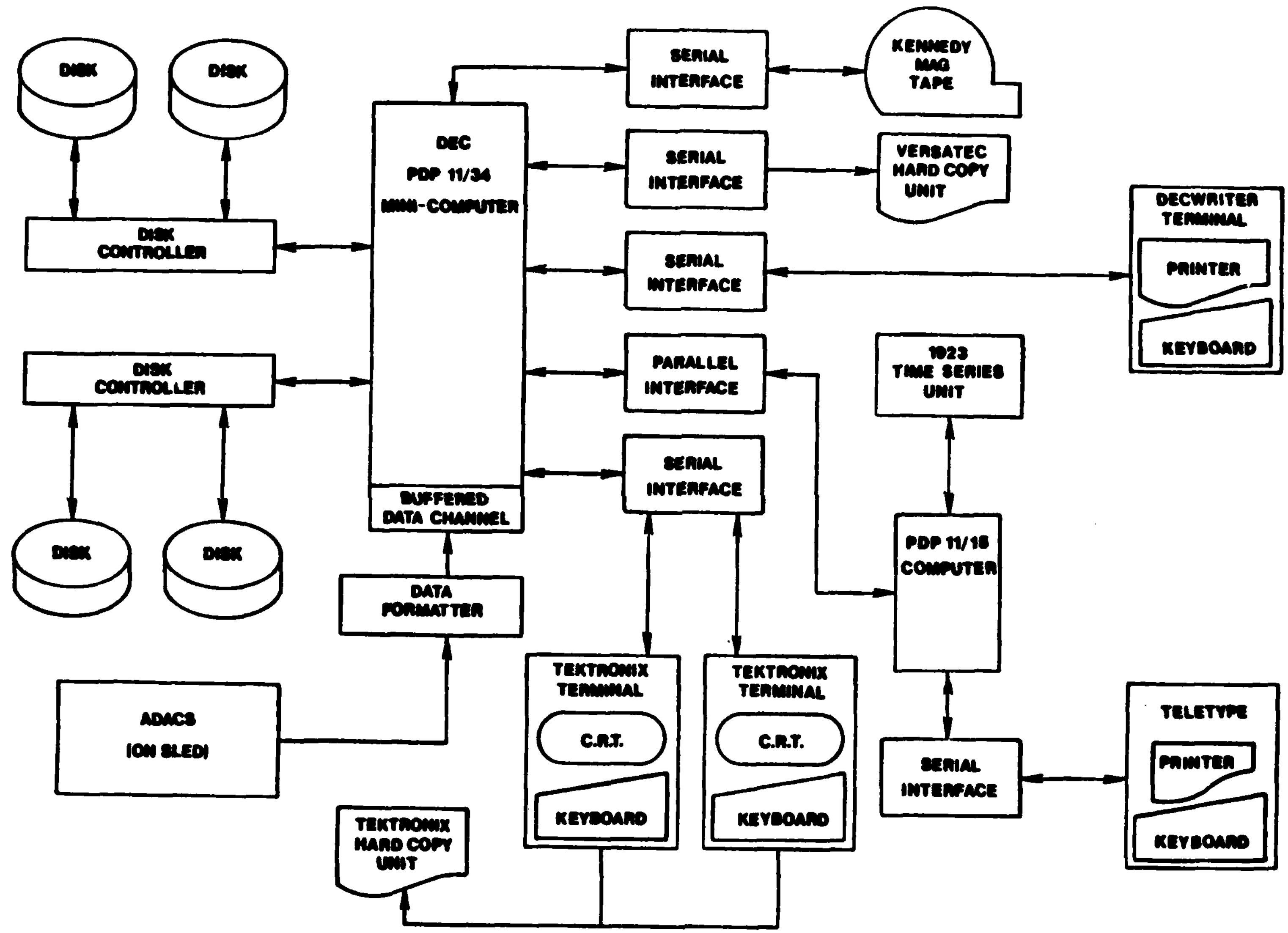


Figure A-3. ADACS Configuration.

Test data were reviewed immediately after each test by using the "Quick-Look" CHAN routine. CHAN may be used to produce a plot of the data stored on any channel as a function of time or to calculate velocity by integrating sled acceleration. The routine determines the minimum and maximum values of any data plot.

A 100 Hz timing reference was an integral part of the data acquisition system. This 100 Hz signal was initiated at T-0 by the countdown clock. Thirty milliseconds after T-0, a second signal mark was generated and provided a temporal reference for electronic and photogrammetric data.

C. PHOTOGRAMMETRIC DATA ACQUISITION AND REDUCTION SYSTEM

Photogrammetric data were acquired through the use of high-speed 16mm cameras operating at a rate of 500 frames per second. The cameras were Photosonic Model No. 16MM-1B pin-registered units which were capable of withstanding 100 G. Two cameras were mounted on the test sled, and one camera was mounted off the sled. During a test, the cameras were started and stopped automatically by the Camera and Lighting Control Station, which is a part of the impact facility safety and control system. The cameras were started at a preset time in the test sequence and ran for four seconds per test.

An automatic film reader (AFR), developed by Photo Digitizing Systems, Inc., was used to digitize and record photographic data on magnetic tape. The subsystem consists of:

- Film motion analyzer with 16mm projection head
- Electronic scanning camera
- Control unit
- Alphanumeric cathode ray tube (CRT)
- Line printer
- Magnetic tape transport

The film reader recognizes quadrant or circular fiducial targets. It automatically tracks and extracts data for up to ten targets per film frame at a minimum rate of one-half film frame per second. The X-Y coordinate position of each target on each film frame is input to the computer and recorded on magnetic tape.

A NOVA 3/12 computer, which contains 16K 16-bit words of core memory, a CRT terminal, and a magnetic tape transport with suitable interface, controls the AFR. In addition, a parallel data link is provided between the NOVA 3/12 and the PDP 11/34 computers.

An alphanumeric CRT (DGC 6052) automatically displays the AFR control information. The CRT display and its keyboard function are used as separate devices. The keyboard is a transmit-only device, and the display is a receive-only device with the additional capability of transmitting cursor position information on program request.

A line printer, LA36 Decwriter II, provides hard copies of the information presented on the 6052 CRT. The LA36 is a medium-sized interaction terminal with a low-speed impact printer and a standard ASCII keyboard consisting of alphanumeric characters and non-printing system control codes.

Either the Decwriter or the 6052 CRT output may be assigned to the PDP 11/34A. Programs can also be established which can "down load" from the disc on the PDP 11/34A to the NOVA, or digital film data can be loaded on the PDP 11/34A for processing and disc storage.

D. VIDEO

An Instar (Instant Analytical Replay) video camera system was used to document each impact event. The videotape was available for review by the test conductor immediately after the impact event.

The Instar is a compact, portable, fully transistorized instrument that combines the long recording capacity and instant replay features of video tape. Each system records 120 frames/second with an effective shutter speed of 10us or less and will play back all recordings in real time, stop action, reverse slow motion, and variable slow motion (2 - 15 percent of real time). Each of the frames is sequential and non-interlaced.

The Instar system that was used incorporated two cameras and a special-effects generator for the added flexibility of split screen. The simultaneous display of two events offers the precise evaluation of three-dimensional problems or the referencing of one physical event to an instrument (i.e., digital clock or oscilloscope).

E. TIMING REFERENCE - PHOTOGRAMMETRIC

The high-speed cameras utilized a light-emitting diode driver, LM Dearing Model 2/3/3R, to place a mark on the film, thereby establishing a time reference. This mark (a red bar) was generated once every ten milliseconds for a duration of 0.75 milliseconds and was initiated at T-0 by the countdown clock. These photo-timing pulses were generated at the same time as the eletronic timing pulses, thus providing temporal correlation between the two signals. A special-event flash was used to mark the film frame at the start of the impact event. This flash consisted of an electronic photo flash which was actuated by the electronic event signal.

APPENDIX B

DATA SUMMARIES AND GRAPHS

This appendix contains the data collected from each test accomplished in this test series. These data are summarized in a table of maximum and minimum values with corresponding times of maximum and minimum values and in graphs of sled accelerations, sled velocity, and loads measured at the restraint tie-down points.

The data printed out in tabular form are identified by an abbreviated title. The data are listed in four columns titled max (the maximum value), min (the minimum value), I1 (the time the maximum valued occurred), and T2 (the time the minimum value occurred). A fifth column identifies the data channel number. The values of time are specified in milliseconds. An event mark is used to synchronize the electronic and photometric data. The event time is the first data value specified on each table. To correlate a time value form one test to another, the reader must calculate the values of T1 and T2 with respect to the common time event mark. For example, if the event mark time is 160 milliseconds and the max value of the resultant shoulder harness load occurs at 300 milliseconds, subtraction of the event mark time from the time of the max resultant shoulder harness load yields the correlated time value, 140 milliseconds.

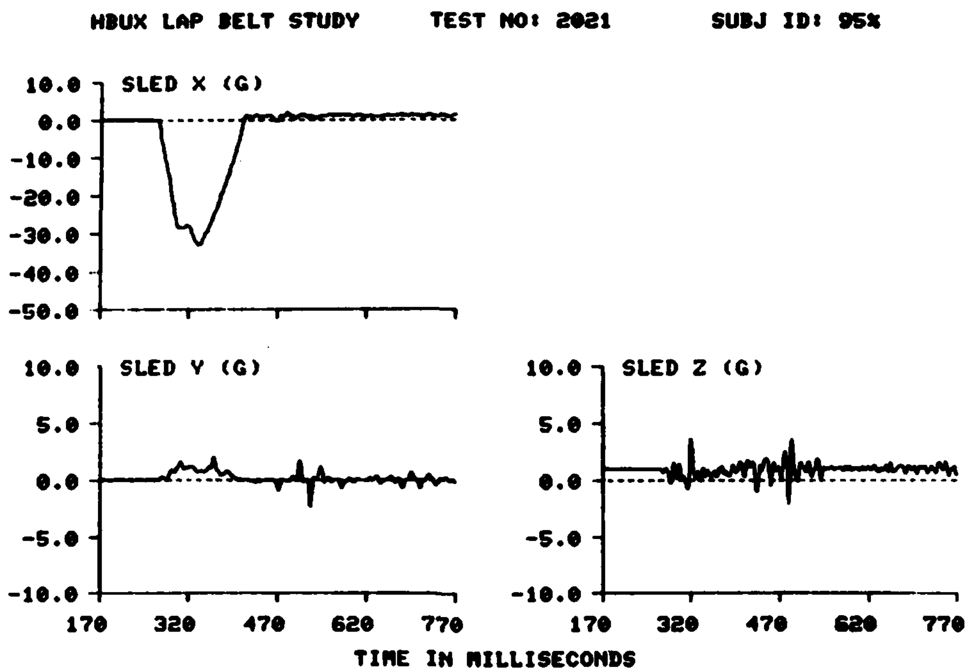
The data titles are defined as follows:

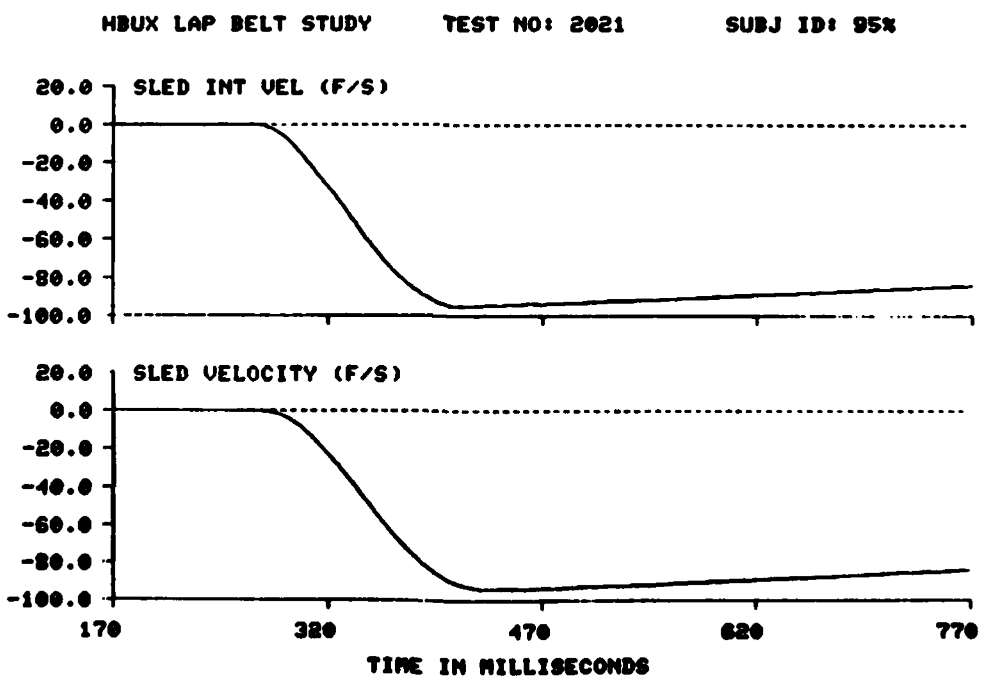
TIME OF EVENT	= Time of event correlation mark
2.5V EXT PWR	= Monitor of 2.5 volt power
10V EXT PWR	= Monitor of 10 volt power
SHD PLD PRIOR EVENT	= Shoulder harness preload prior to impact
LF LAP PLD PRIOR EVENT	= Left lap belt preload prior to impact
RT LAP PLD PRIOR EVENT	= Right lap belt preload prior to impact
SLED X ACCEL	= Sled acceleration in the X axis
SLED X ACCEL (SM)	= Sled X acceleration smoothed using a point-moving average method
SLED Y ACCEL	= Sled acceleration in the Y axis
SLED Z ACCEL	= Sled acceleration in the Z axis
N-G STRAP	= The load acting at the crotch strap tie-down point

SLED VEL (INT ACCEL)	= Sled velocity computed by intergration of sled acceleration
SLED VELOCITY	= Sled velocity computed from the tachometer
VEL AT EVENT	= The velocity at event
SHOULDER LOAD X	= The X axis component of the load acting at the shoulder harness tie-down point
SHOULDER LOAD Y	= The Y axis component of the load acting at the shoulder harness tie-down point
SHOULDER LOAD Z	= The Z axis component of the load acting at the shoulder harness tie-down point
SHOULDER RESULTANT	= The resultant of the continuously summed shoulder harness load components
SHOULDER RES/WT	= The maximum resultant shoulder harness load divided by the total weight of the subject
LF LAP LOAD X	= The X axis component of the load acting at the left lap belt tie-down point
LF LAP LOAD Y	= The Y axis component of the load acting at the left lap belt tie-down point
LF LAP LOAD Z	= The Z axis component of the load acting at the left lap belt tie-down point
LF LAP RESULTANT	= The resultant of the continuously summed left lap belt load components
RT LAP LOAD X	= The X axis component of the load acting at the right lap belt tie-down point
RT LAP LOAD Y	= The Y axis component of the load acting at the right lap belt tie-down point
RT LAP LOAD Z	= The Z axis component of the load acting at the right lap belt tie-down point
RT LAP RESULTANT	= The resultant of the continuously summed right lap belt load components

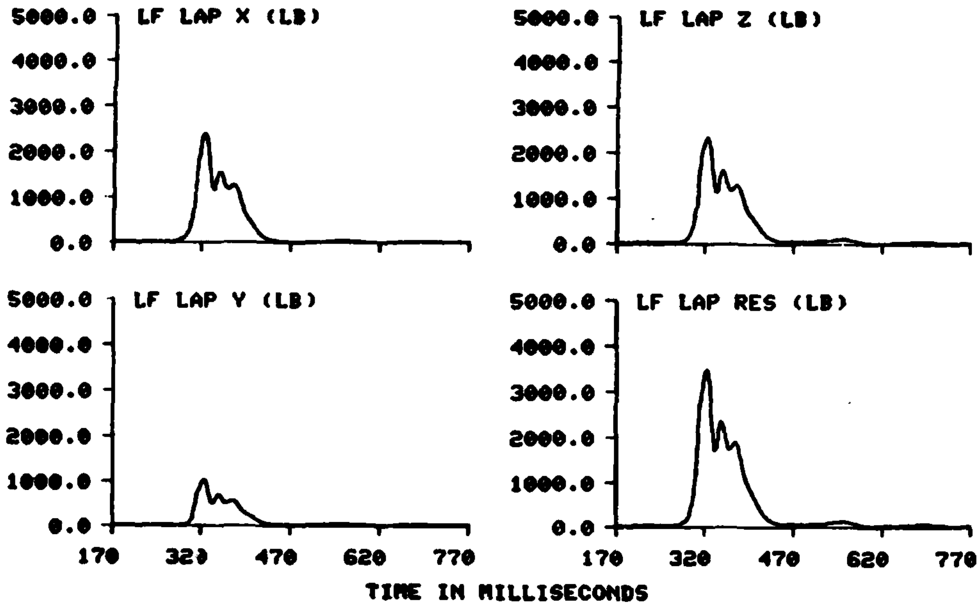
MBUX LAP BELT STUDY TEST: 2021 SUBJ: 95% WT: 204.0 NOM G: 32.0 CELL: X

DATA ID	MAX	MIN	T1	T2	CH
TIME OF EVENT			175.00		37
2.5V EXT PWR	2.51	2.49	957.00	143.00	47
10V EXT PWR	10.01	9.98	419.00	56.00	48
SHD PLD PRIOR EVENT	21.91		70.00	170.00	
LF LAP PLD PRIOR EVENT	34.62		70.00	170.00	
RT LAP PLD PRIOR EVENT	32.04		70.00	170.00	
SLED X ACCEL	1.97	-32.81	486.00	336.00	1
SLED X ACCEL (SM)	1.51	-32.58	485.00	337.00	
SLED Y ACCEL	2.02	-2.31	362.00	526.00	2
SLED Z ACCEL	3.64	-2.13	490.00	485.00	3
SLED VEL (INT ACCEL)	0.09	-95.11	240.00	412.00	
SLED VELOCITY	0.22	-94.28	195.00	435.00	29
VEL AT EVENT		-94.28		435.00	
SHOULDER LOAD X	3845.52	-36.07	319.00	470.00	23
SHOULDER LOAD Y	137.69	-43.33	339.00	304.00	22
SHOULDER LOAD Z	873.41	-9.78	321.00	484.00	21
SHOULDER RESULTANT	3940.46	0.33	319.00	577.00	
LF LAP LOAD X	2389.82	-14.97	324.00	493.00	15
LF LAP LOAD Y	1016.49	-6.29	324.00	638.00	16
LF LAP LOAD Z	2312.54	1.76	322.00	610.00	17
LF LAP RESULTANT	3472.08	5.22	324.00	610.00	
RT LAP LOAD X	2292.21	-25.04	325.00	718.00	18
RT LAP LOAD Y	1304.74	-7.05	324.00	590.00	19
RT LAP LOAD Z	2408.11	-0.17	325.00	617.00	20
RT LAP RESULTANT	3570.57	3.11	325.00	617.00	

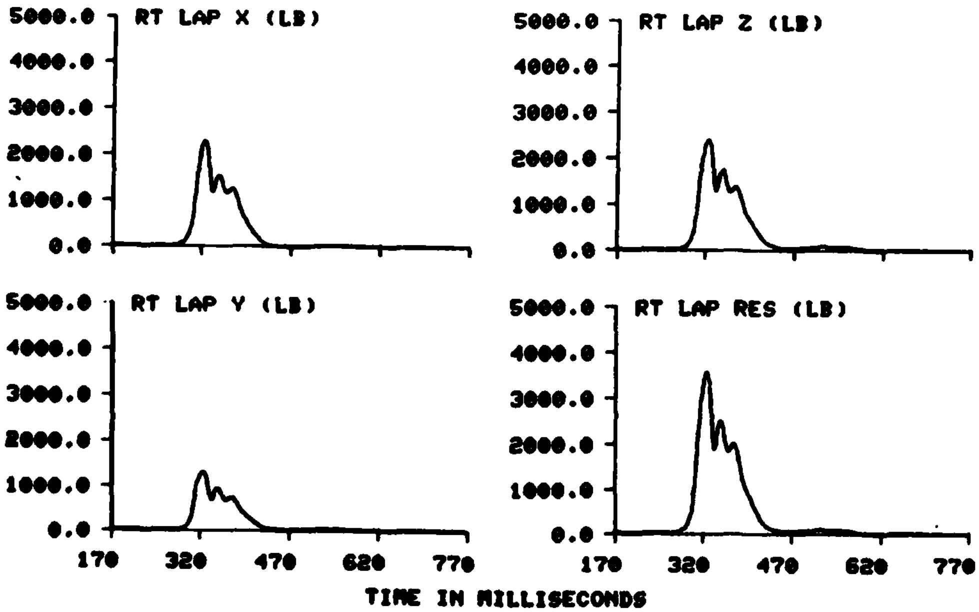

HBUX LAP BELT STUDY
TEST NO: 2021
SUBJ ID: 95%
SLED X (G)
SLED Y (G)
SLED Z (G)
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
5.0
-5.0
170
320
470
620
770
TIME IN MILLISECONDS


HBUX LAP BELT STUDY
TEST NO: 2021
SUBJ ID: 95%
SLED INT VEL (F/S)
SLED VELOCITY (F/S)
20.0
0.0
-20.0
-40.0
-60.0
-80.0
-100.0
170
320
470
620
770
TIME IN MILLISECONDS

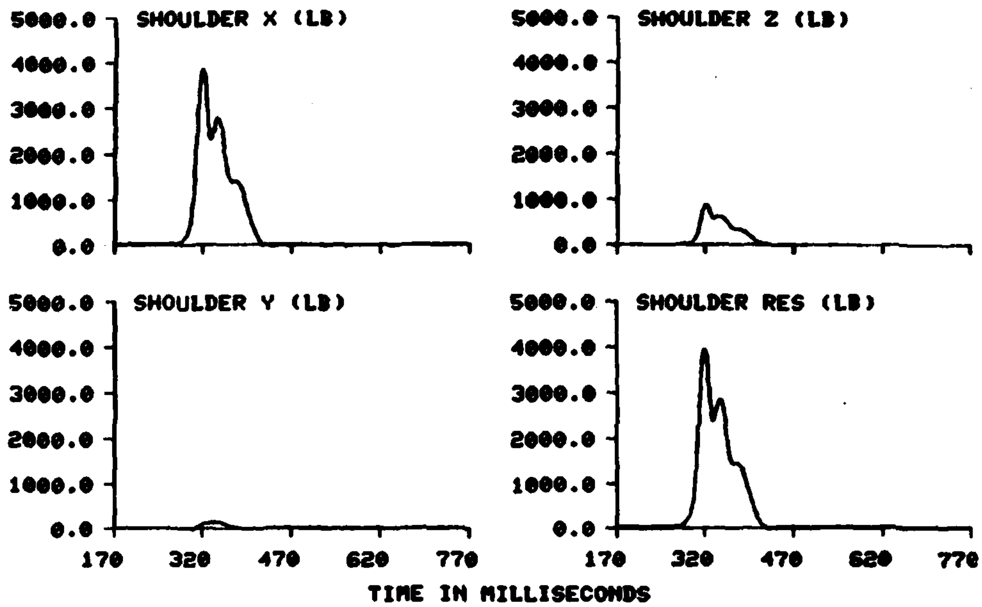
HBUX LAP BELT STUDY TEST NO: 2021 SUBJ ID: 95%



HBUX LAP BELT STUDY TEST NO: 2021 SUBJ ID: 95%



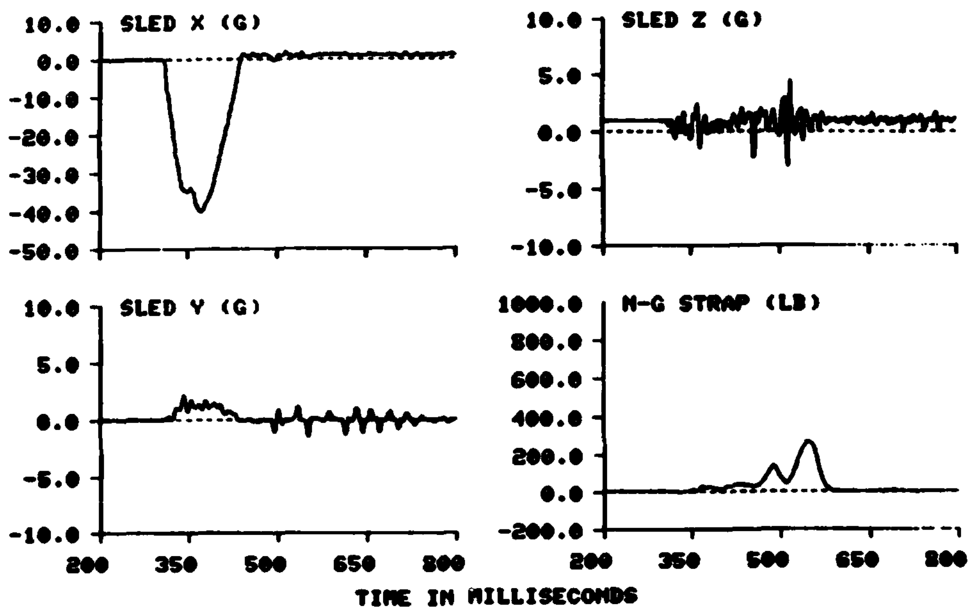
HBUX LAP BELT STUDY TEST NO: 2021 SUBJ ID: 95%



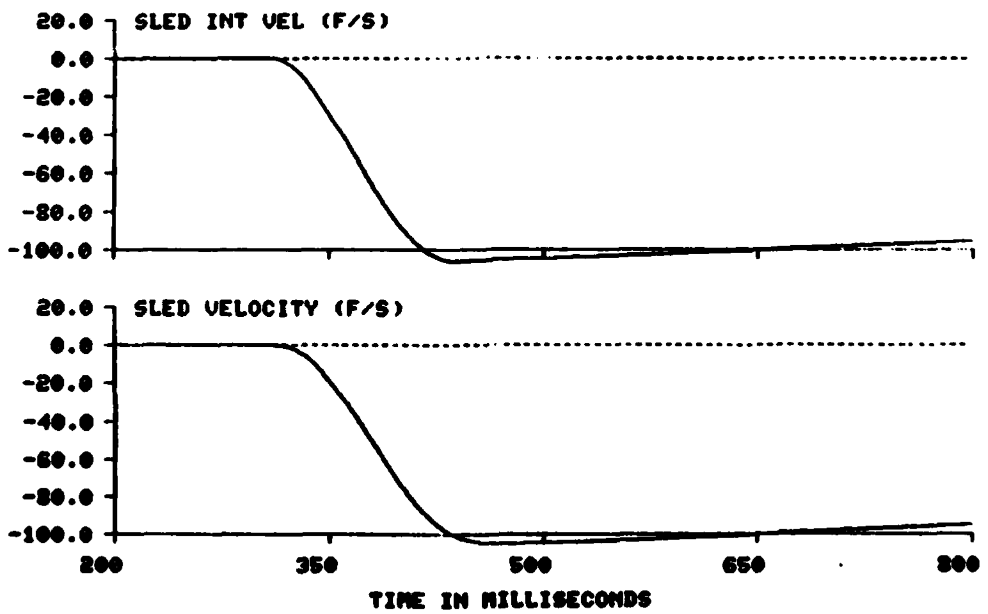
HBUX LAP BELT STUDY TEST: 2022 SUBJ: 95% WT: 204.0 NOM G: 40.0 CELL: X

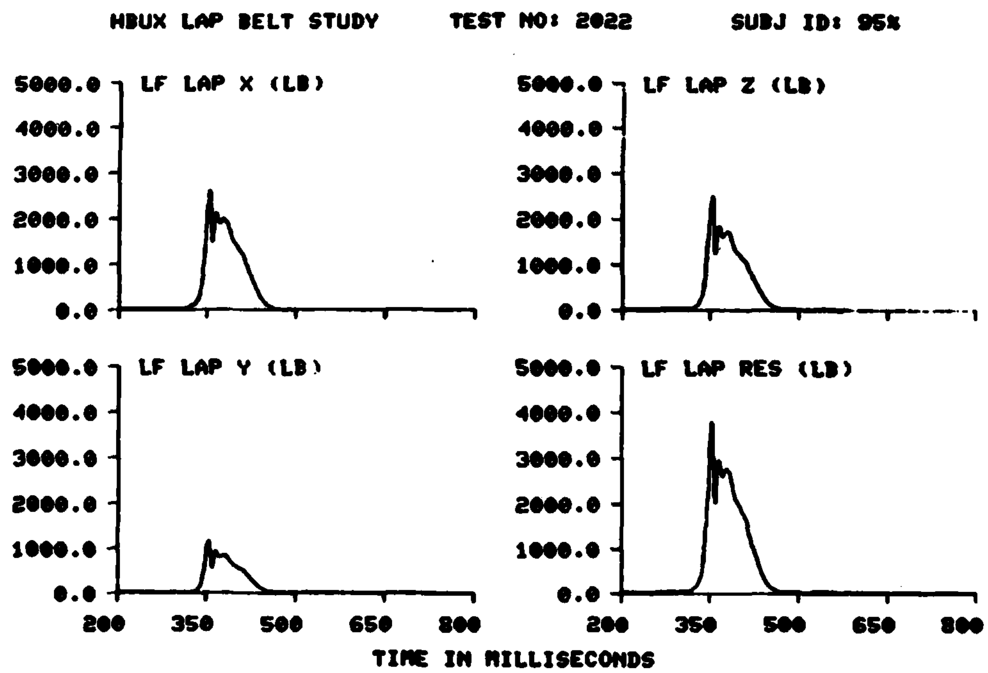
DATA ID	MAX	MIN	T1	T2	CH
TIME OF EVENT			207.00		37
2.5V EXT PWR	2.51	2.49	358.00	33.00	47
10V EXT PWR	10.01	9.97	459.00	227.00	48
SHD PLD PRIOR EVENT	28.94		100.00	200.00	
LF LAP PLD PRIOR EVENT	38.48		100.00	200.00	
RT LAP PLD PRIOR EVENT	34.62		100.00	200.00	
SLED X ACCEL	1.84	-40.19	514.00	371.00	1
SLED X ACCEL (SM)	1.44	-39.84	514.00	371.00	
SLED Y ACCEL	2.12	-1.46	341.00	552.00	2
SLED Z ACCEL	4.47	-2.99	519.00	514.00	3
N-G STRAP	266.58	-2.12	543.00	327.00	30
SLED VEL (INT ACCEL)	0.02	-106.06	288.00	439.00	
SLED VELOCITY	0.16	-105.29	279.00	475.00	29
VEL AT EVENT		-105.29		475.00	
SHOULDER LOAD X	4424.22	-33.45	356.00	497.00	23
SHOULDER LOAD Y	150.20	-43.36	367.00	343.00	22
SHOULDER LOAD Z	1023.14	-13.33	360.00	514.00	21
SHOULDER RESULTANT	4531.51	2.04	356.00	551.00	
LF LAP LOAD X	2592.32	-20.73	353.00	700.00	15
LF LAP LOAD Y	1140.81	-15.58	354.00	788.00	16
LF LAP LOAD Z	2502.52	-20.51	353.00	743.00	17
LF LAP RESULTANT	3777.35	1.32	353.00	598.00	
RT LAP LOAD X	2528.38	-31.20	360.00	707.00	18
RT LAP LOAD Y	1309.81	-9.59	355.00	838.00	19
RT LAP LOAD Z	2608.69	-18.15	355.00	613.00	20
RT LAP RESULTANT	3828.95	1.97	355.00	642.00	

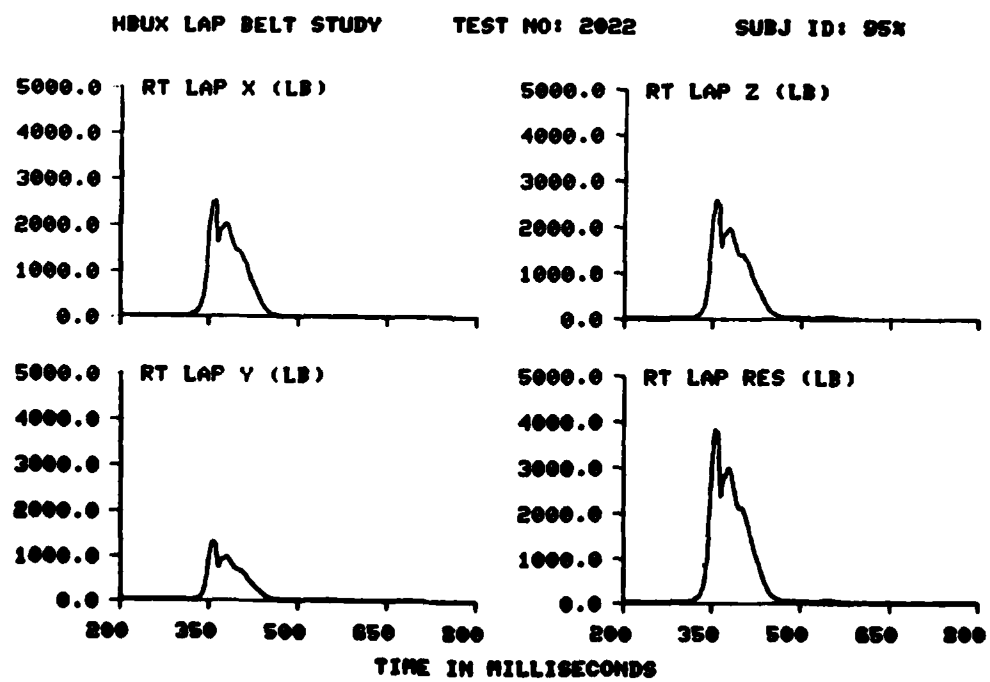
HBUX LAP BELT STUDY TEST NO: 2022 SUBJ ID: 95%



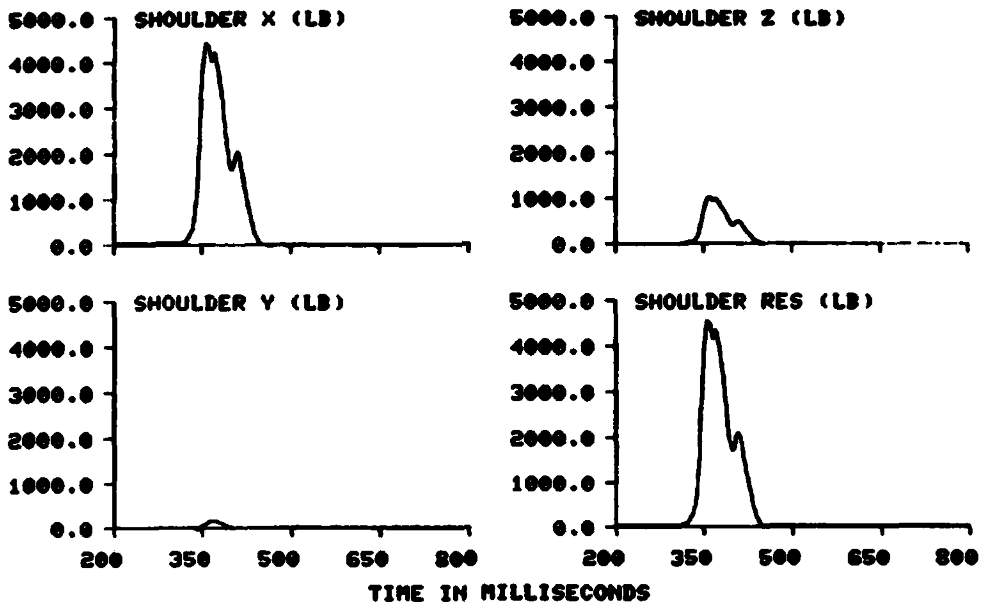
HBUX LAP BELT STUDY TEST NO: 2022 SUBJ ID: 95%




HBUX LAP BELT STUDY
TEST NO: 2022
SUBJ ID: 95%
LF LAP X (LB)
LF LAP Z (LB)
LF LAP Y (LB)
LF LAP RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
200
350
500
650
800
TIME IN MILLISECONDS

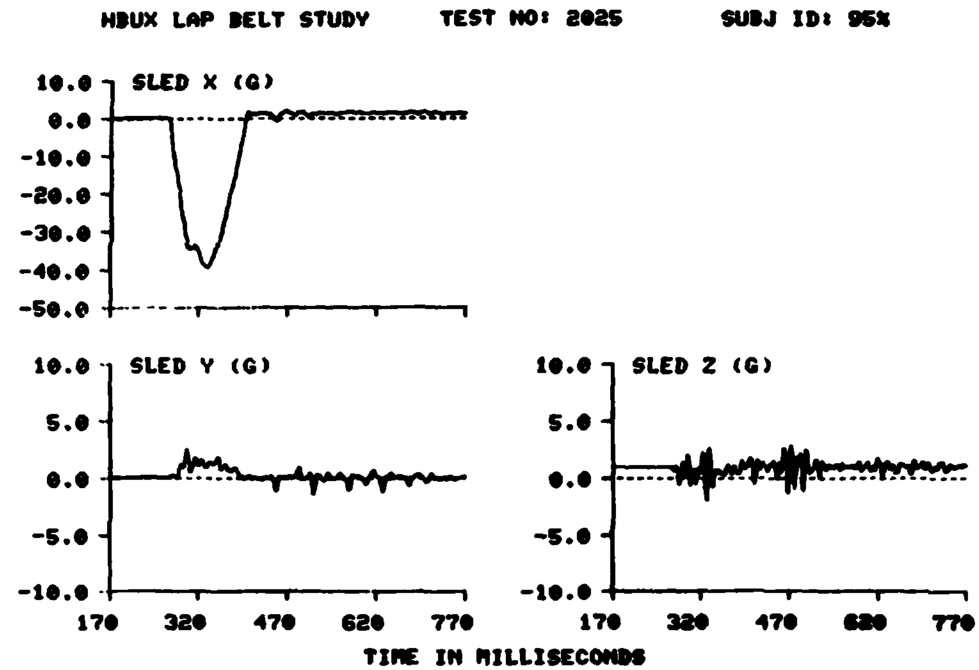

HBUX LAP BELT STUDY
TEST NO: 2022
SUBJ ID: 95%
RT LAP X (LB)
RT LAP Z (LB)
RT LAP Y (LB)
RT LAP RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
200
350
500
650
800
TIME IN MILLISECONDS

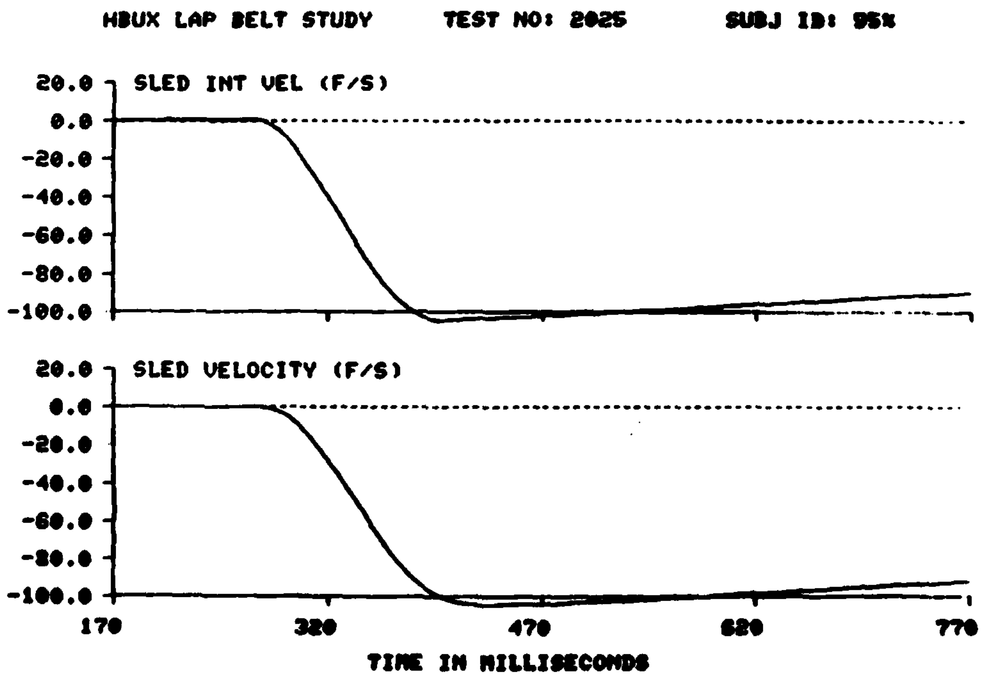
HBUX LAP BELT STUDY   TEST NO: 2022   SUBJ ID: 95%

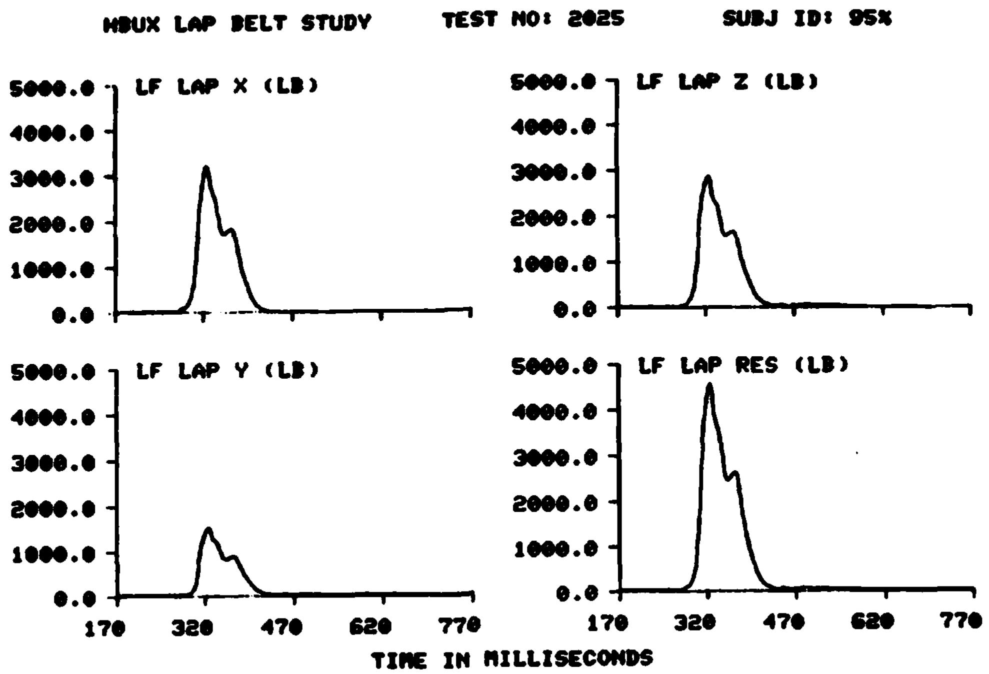


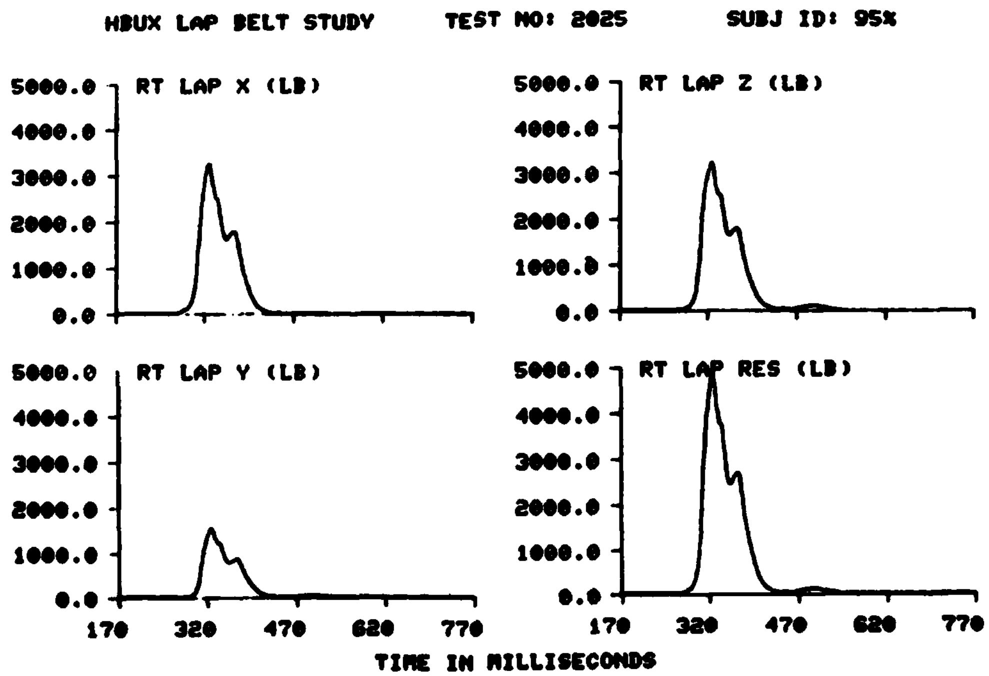
HBUX LAP BELT STUDY   TEST: 2025   SUBJ: 95%   WT: 204.0   NOM G: 40.0   CELL: X

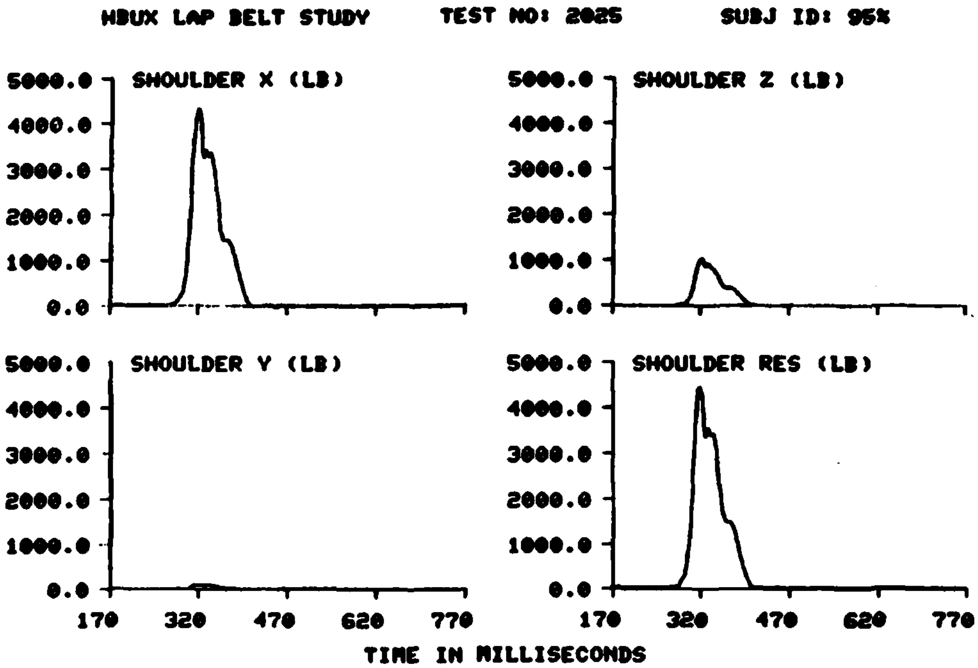
DATA ID	MAX	MIN	T1	T2	CH
TIME OF EVENT			173.00		37
2.5V EXT PWR	2.50	2.49	280.00	208.00	47
10V EXT PWR	10.03	9.98	53.00	48.00	48
SHD PLD PRIOR EVENT	22.52		70.00	170.00	
LF LAP PLD PRIOR EVENT	25.27		70.00	170.00	
RT LAP PLD PRIOR EVENT	30.22		70.00	170.00	
SLED X ACCEL	1.87	-39.39	466.00	333.00	1
SLED X ACCEL (SM)	1.77	-39.11	466.00	334.00	
SLED Y ACCEL	2.49	-1.42	300.00	514.00	2
SLED Z ACCEL	2.86	-1.96	473.00	329.00	3
SLED VEL (INT ACCEL)	0.14	-104.51	262.00	399.00	
SLED VELOCITY	0.19	-104.79	171.00	431.00	29
VEL AT EVENT		-104.79		431.00	
SHOULDER LOAD X	4339.52	-38.70	316.00	451.00	23
SHOULDER LOAD Y	86.62	-14.96	318.00	289.00	22
SHOULDER LOAD Z	1033.51	-10.27	321.00	467.00	21
SHOULDER RESULTANT	4452.54	1.17	316.00	723.00	
LF LAP LOAD X	3202.29	-10.71	325.00	219.00	15
LF LAP LOAD Y	1507.42	-7.98	325.00	687.00	16
LF LAP LOAD Z	2867.36	-16.10	325.00	709.00	17
LF LAP RESULTANT	4555.08	1.62	325.00	708.00	
RT LAP LOAD X	3267.28	-19.28	326.00	717.00	18
RT LAP LOAD Y	1544.06	-13.85	326.00	634.00	19
RT LAP LOAD Z	3229.57	-19.96	326.00	614.00	20
RT LAP RESULTANT	4846.58	1.62	326.00	577.00	


HBUX LAP BELT STUDY TEST NO: 2025 SUBJ ID: 95%
SLED X (G)
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
SLED Y (G)
SLED Z (G)
10.0
5.0
0.0
-5.0
-10.0
170
320
470
620
770
TIME IN MILLISECONDS


HBUX LAP BELT STUDY TEST NO: 2025 SUBJ ID: 95%
SLED INT VEL (F/S)
SLED VELOCITY (F/S)
20.0
0.0
-20.0
-40.0
-60.0
-80.0
-100.0
170
320
470
620
770
TIME IN MILLISECONDS

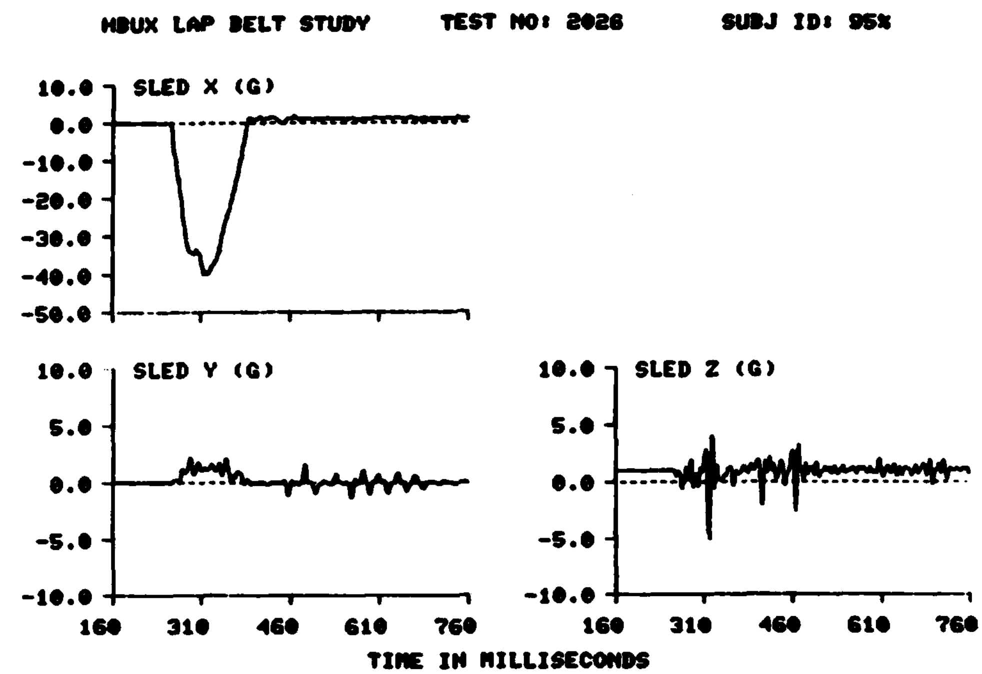

HBUX LAP BELT STUDY
TEST NO: 2025
SUBJ ID: 95%
LF LAP X (LB)
LF LAP Z (LB)
LF LAP Y (LB)
LF LAP RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
170
320
470
620
770
TIME IN MILLISECONDS

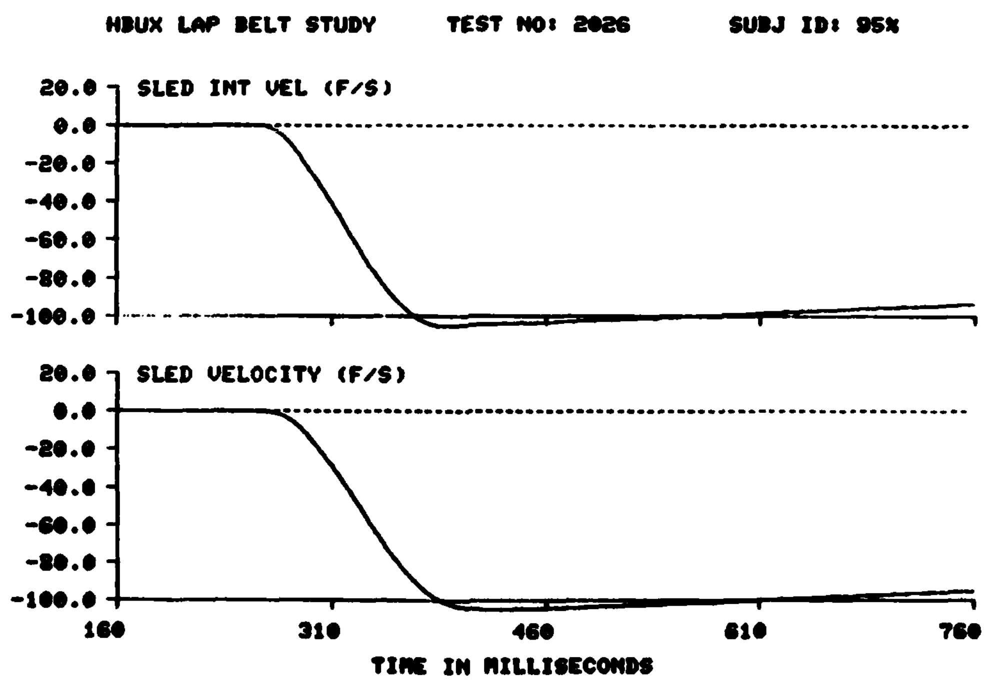

HBUX LAP BELT STUDY
TEST NO: 2025
SUBJ ID: 95%
RT LAP X (LB)
RT LAP Z (LB)
RT LAP Y (LB)
RT LAP RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
170
320
470
620
770
TIME IN MILLISECONDS

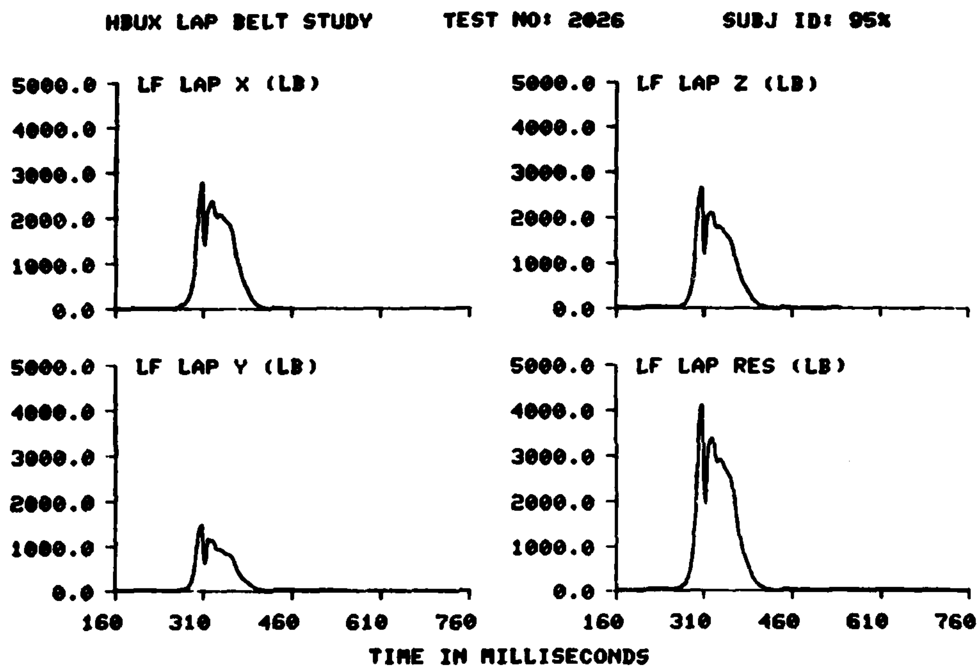

HBUX LAP BELT STUDY
TEST NO: 2025
SUBJ ID: 95%
SHOULDER X (LB)
SHOULDER Z (LB)
SHOULDER Y (LB)
SHOULDER RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
170
320
470
620
770
TIME IN MILLISECONDS

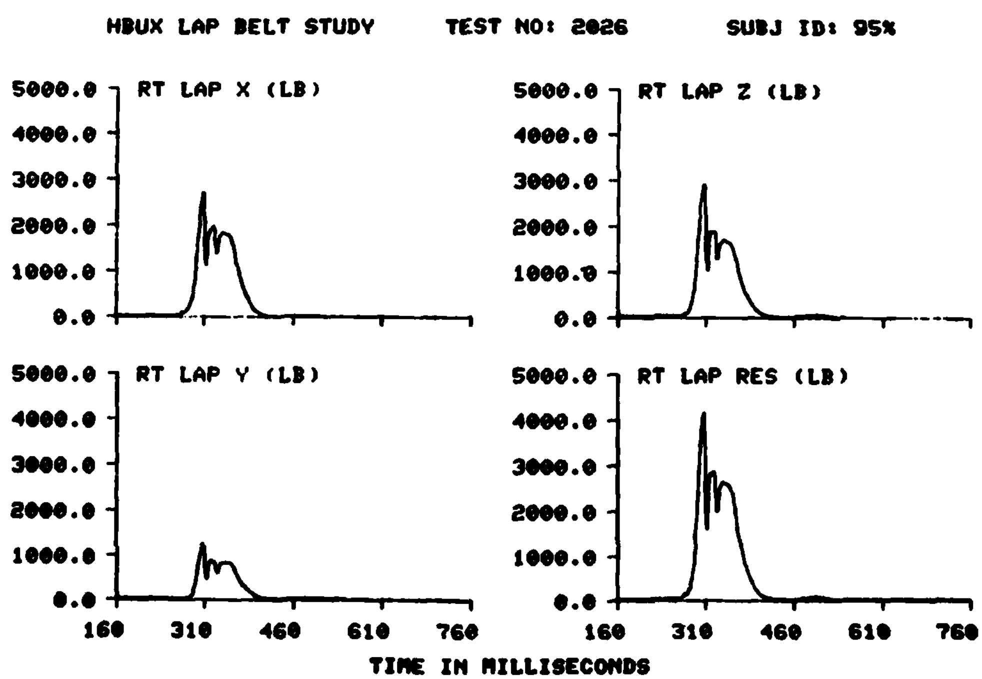
HBUX LAP BELT STUDY TEST: 2026 SUBJ: 95% WT: 204.0 NOM G: 40.0 CELL: X

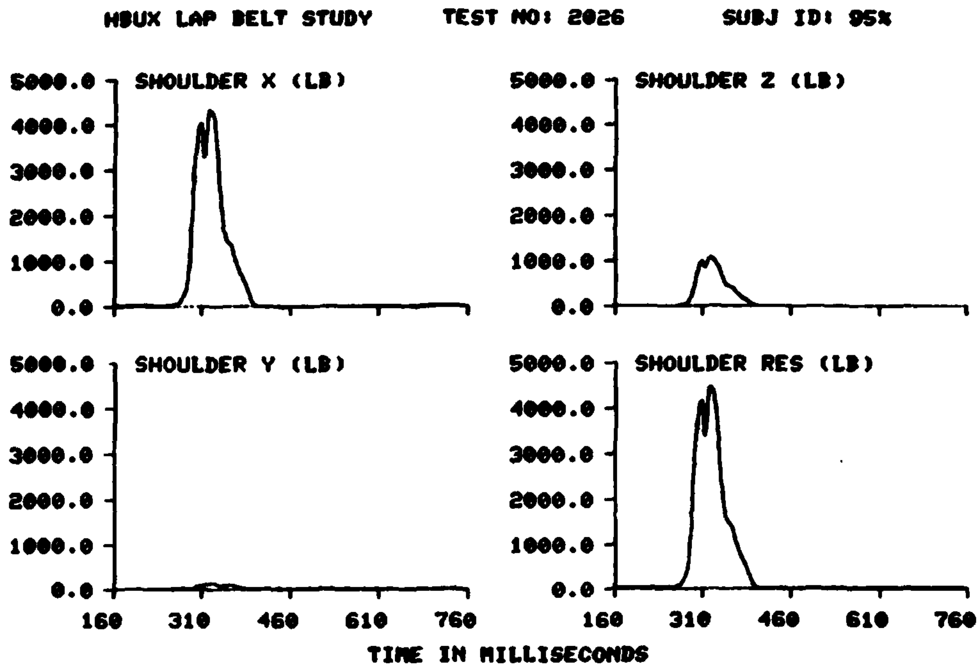
DATA ID	MAX	MIN	T1	T2	CH
TIME OF EVENT			160.00		37
2.5V EXT PWR	2.51	2.49	293.00	37.00	47
10V EXT PWR	10.02	9.98	583.00	109.00	48
SHD PLD PRIOR EVENT	27.75		60.00	160.00	
LF LAP PLD PRIOR EVENT	34.94		60.00	160.00	
RT LAP PLD PRIOR EVENT	38.62		80.00	160.00	
SLED X ACCEL	1.71	-39.96	466.00	316.00	1
SLED X ACCEL (SM)	1.37	-39.62	466.00	320.00	
SLED Y ACCEL	2.20	-1.31	291.00	564.00	2
SLED Z ACCEL	3.98	-5.02	324.00	319.00	3
SLED VEL (INT ACCEL)	0.04	-105.15	233.00	388.00	
SLED VELOCITY	0.24	-105.33	188.00	429.00	29
VEL AT EVENT		-105.39		429.00	
SHOULDER LOAD X	4319.58	-34.80	321.00	447.00	23
SHOULDER LOAD Y	135.62	-11.25	324.00	485.00	22
SHOULDER LOAD Z	1081.73	-10.71	322.00	647.00	21
SHOULDER RESULTANT	4454.78	1.37	322.00	571.00	
LF LAP LOAD X	2794.42	-16.96	307.00	461.00	15
LF LAP LOAD Y	1476.22	-8.68	307.00	649.00	16
LF LAP LOAD Z	2849.02	-18.18	306.00	678.00	17
LF LAP RESULTANT	4118.61	2.87	307.00	559.00	
RT LAP LOAD X	2718.41	-22.92	307.00	699.00	18
RT LAP LOAD Y	1270.18	-11.16	307.00	549.00	19
RT LAP LOAD Z	2905.44	-22.43	306.00	729.00	20
RT LAP RESULTANT	4151.64	3.12	306.00	633.00	


HBUX LAP BELT STUDY
TEST NO: 2026
SUBJ ID: 95%
SLED X (G)
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
SLED Y (G)
10.0
5.0
0.0
-5.0
-10.0
SLED Z (G)
10.0
5.0
0.0
-5.0
-10.0
160
310
460
610
760
TIME IN MILLISECONDS


HBUX LAP BELT STUDY
TEST NO: 2026
SUBJ ID: 95%
SLED INT VEL (F/S)
20.0
0.0
-20.0
-40.0
-60.0
-80.0
-100.0
SLED VELOCITY (F/S)
20.0
0.0
-20.0
-40.0
-60.0
-80.0
-100.0
160
310
460
610
760
TIME IN MILLISECONDS

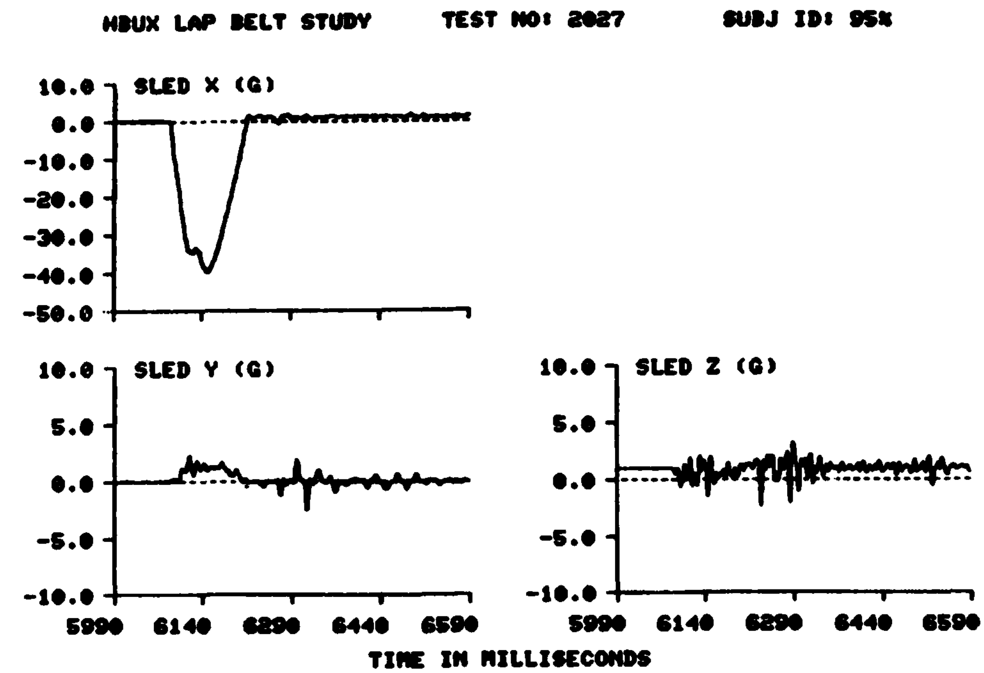

HBUX LAP BELT STUDY
TEST NO: 2026
SUBJ ID: 95%
LF LAP X (LB)
LF LAP Z (LB)
LF LAP Y (LB)
LF LAP RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
160
310
460
610
760
TIME IN MILLISECONDS

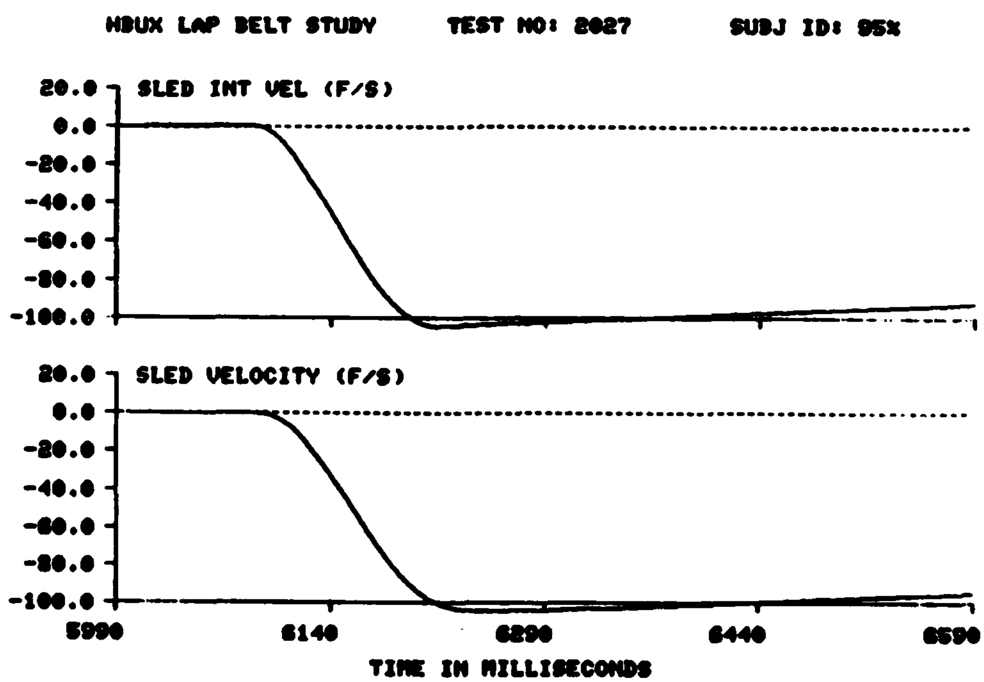

HBUX LAP BELT STUDY
TEST NO: 2026
SUBJ ID: 95%
RT LAP X (LB)
RT LAP Z (LB)
RT LAP Y (LB)
RT LAP RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
160
310
460
610
760
TIME IN MILLISECONDS

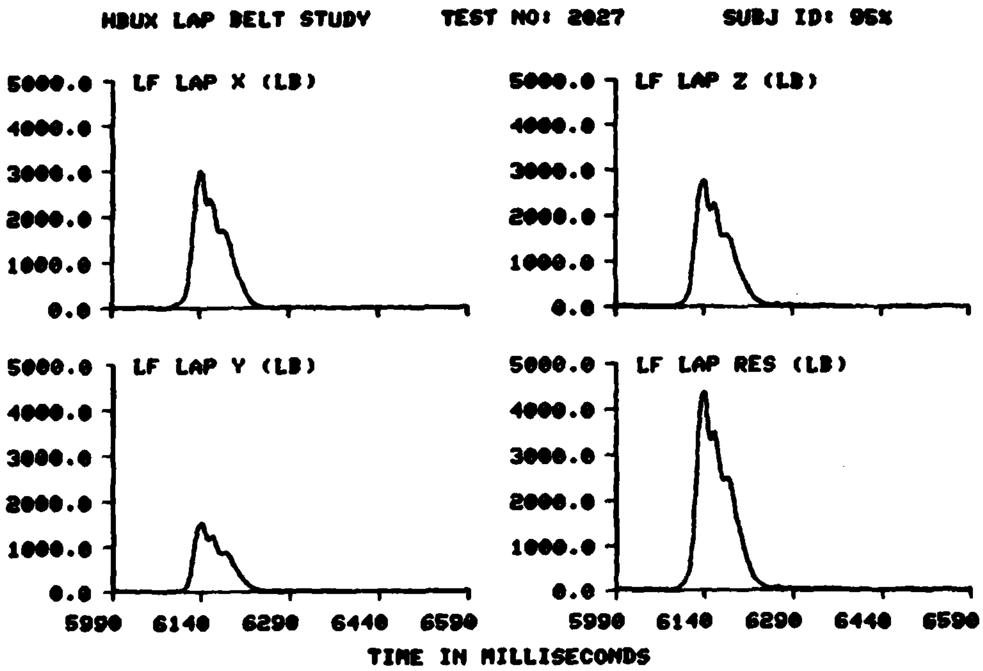

HBUX LAP BELT STUDY
TEST NO: 2026
SUBJ ID: 95%
SHOULDER X (LB)
SHOULDER Z (LB)
SHOULDER Y (LB)
SHOULDER RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
160
310
460
610
760
TIME IN MILLISECONDS

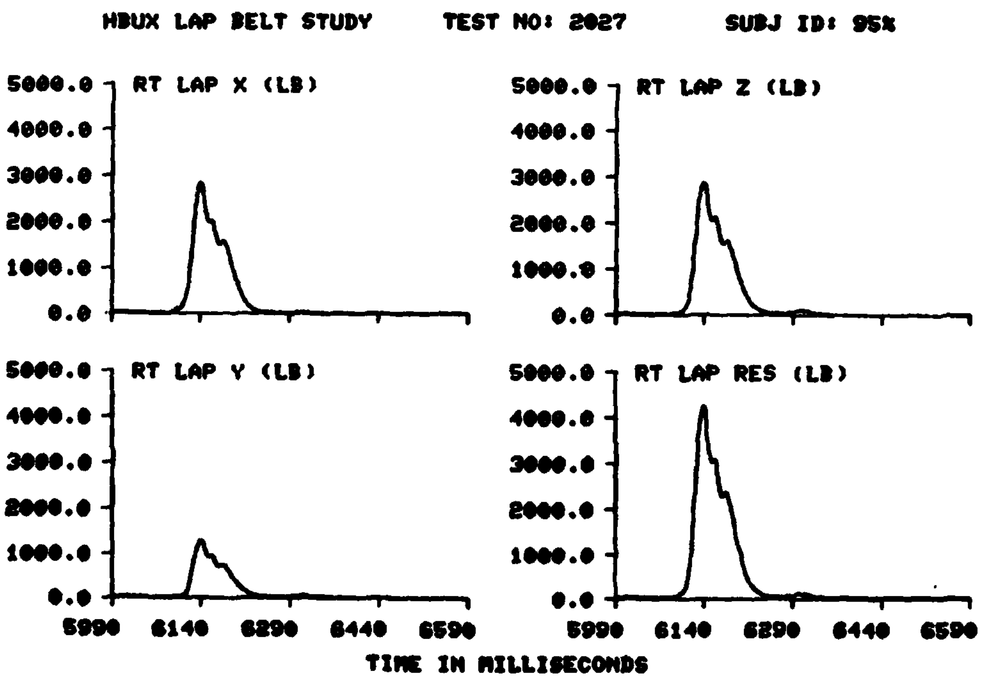
MBUX LAP BELT STUDY TEST: 2027 SUBJ: 95% WT: 204.0 NOM G: 40.0 CELL: X

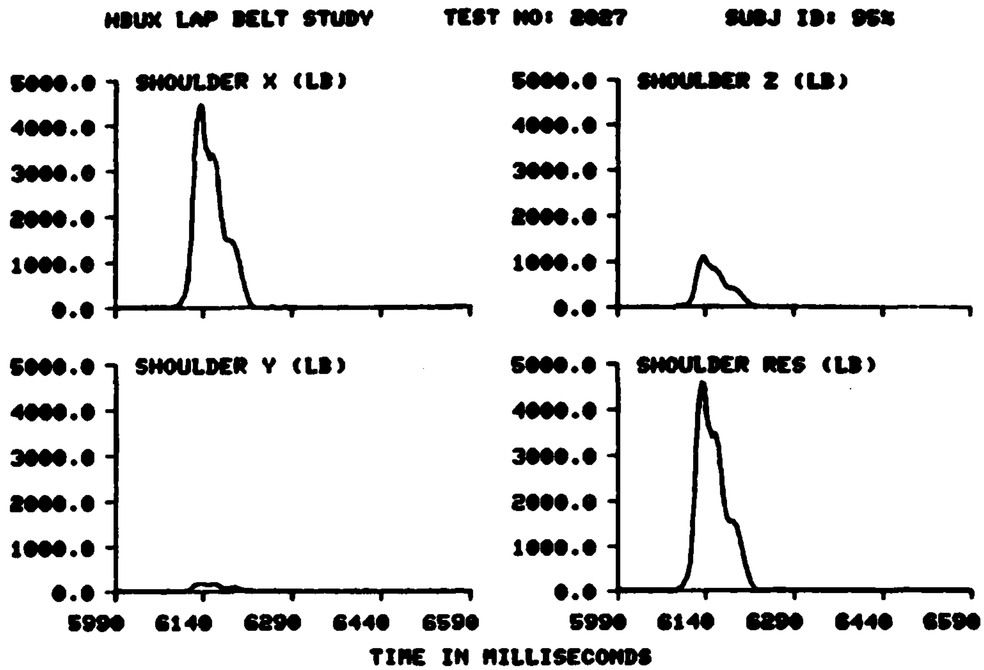
DATA ID	MAX	MIN	T1	T2	CH
TIME OF EVENT			5891.00		37
2.5V EXT PWR	2.51	2.49	124.00	69.00	47
10V EXT PWR	10.01	9.98	471.00	39.00	48
SHD PLD PRIOR EVENT	23.13		5890.00	5990.00	
LF LAP PLD PRIOR EVENT	33.53		5890.00	5990.00	
RT LAP PLD PRIOR EVENT	30.65		5890.00	5990.00	
SLED X ACCEL	1.71	-39.78	6283.00	6150.00	1
SLED X ACCEL (SM)	1.40	-39.42	6282.00	6149.00	
SLED Y ACCEL	2.25	-2.45	6117.00	6316.00	2
SLED Z ACCEL	3.25	-2.36	6289.00	6235.00	3
SLED VEL (INT ACCEL)	0.24	-104.49	6082.00	6214.00	
SLED VELOCITY	0.20	-104.96	6015.00	6253.00	29
VEL AT EVENT		-104.96		6253.00	
SHOULDER LOAD X	4461.89	-31.54	6134.00	6268.00	23
SHOULDER LOAD Y	174.04	-12.68	6156.00	6288.00	22
SHOULDER LOAD Z	1105.53	-11.24	6136.00	6284.00	21
SHOULDER RESULTANT	4592.51	0.97	6134.00	6425.00	
LF LAP LOAD X	3011.89	-17.65	6140.00	6411.00	15
LF LAP LOAD Y	1525.67	-8.49	6140.00	6416.00	16
LF LAP LOAD Z	2781.48	-13.86	6139.00	6448.00	17
LF LAP RESULTANT	4361.75	2.99	6140.00	6409.00	
RT LAP LOAD X	2847.75	-19.79	6139.00	6345.00	18
RT LAP LOAD Y	1280.43	-16.14	6140.00	6400.00	19
RT LAP LOAD Z	2877.15	-17.73	6139.00	6440.00	20
RT LAP RESULTANT	4244.91	1.59	6139.00	6416.00	


HBUX LAP BELT STUDY
TEST NO: 2027
SUBJ ID: 95%
SLED X (G)
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
SLED Y (G)
10.0
5.0
0.0
-5.0
-10.0
SLED Z (G)
10.0
5.0
0.0
-5.0
-10.0
5990
6140
6290
6440
6590
TIME IN MILLISECONDS


HBUX LAP BELT STUDY
TEST NO: 2027
SUBJ ID: 95%
SLED INT VEL (F/S)
20.0
0.0
-20.0
-40.0
-60.0
-80.0
-100.0
SLED VELOCITY (F/S)
20.0
0.0
-20.0
-40.0
-60.0
-80.0
-100.0
5990
6140
6290
6440
6590
TIME IN MILLISECONDS

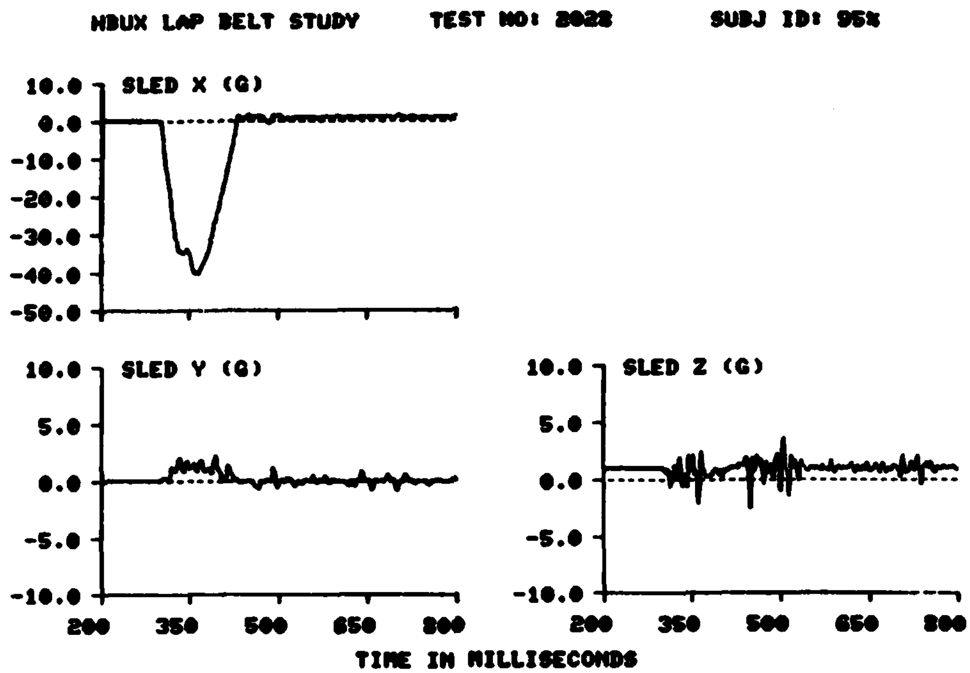

HBUX LAP BELT STUDY
TEST NO: 2027
SUBJ ID: 95%
LF LAP X (LB)
LF LAP Z (LB)
LF LAP Y (LB)
LF LAP RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
5990
6140
6290
6440
6590
TIME IN MILLISECONDS

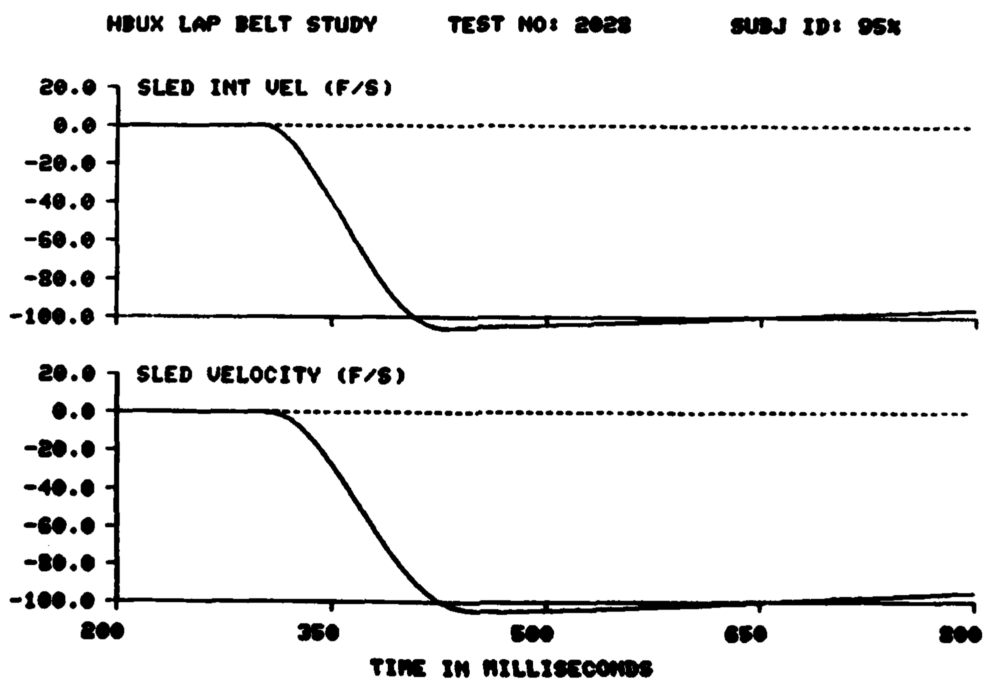

HBUX LAP BELT STUDY
TEST NO: 2027
SUBJ ID: 95%
RT LAP X (LB)
RT LAP Z (LB)
RT LAP Y (LB)
RT LAP RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
5990
6140
6290
6440
6590
TIME IN MILLISECONDS

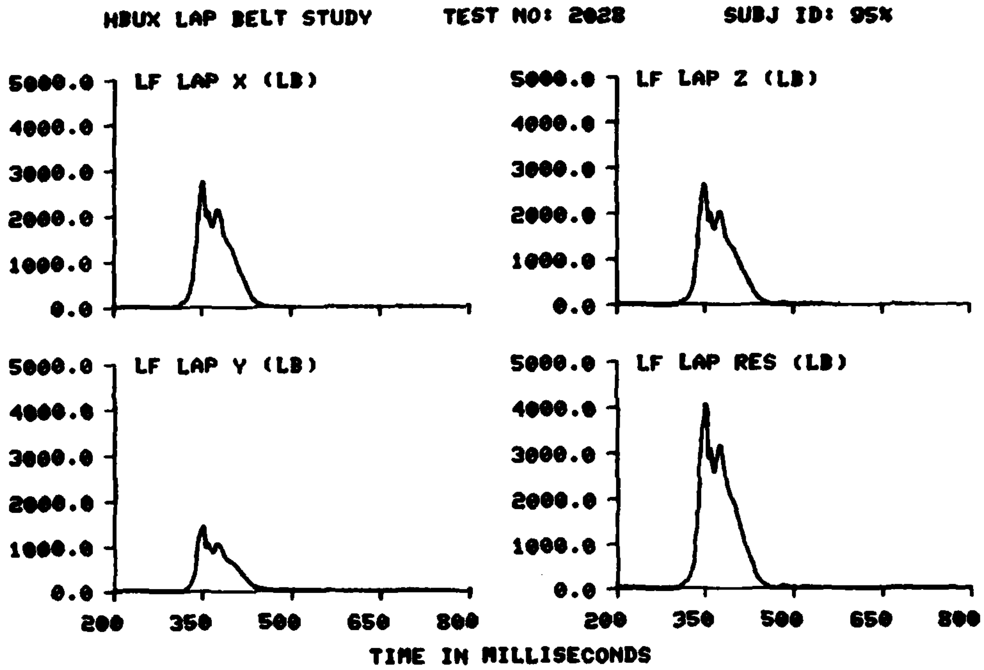

HBUX LAP BELT STUDY TEST NO: 2027 SUBJ ID: 95%
SHOULDER X (LB)
SHOULDER Z (LB)
SHOULDER Y (LB)
SHOULDER RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
5990 6140 6290 6440 6590
TIME IN MILLISECONDS

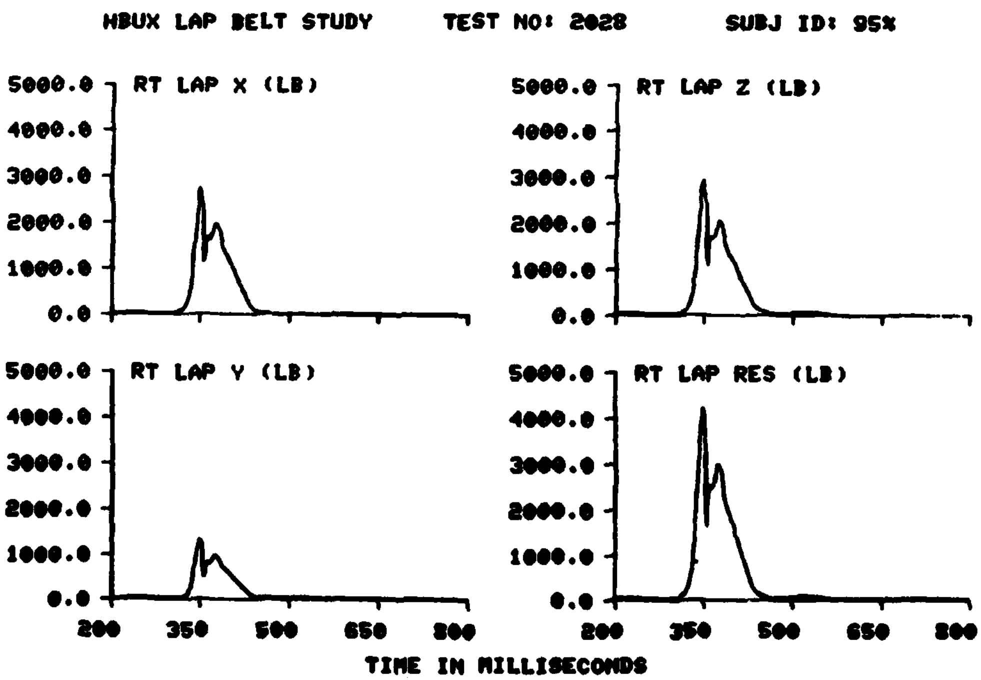
MBUX LAP BELT STUDY TEST: 2028 SUBJ: 95% WT: 204.0 NOM G: 40.0 CELL: X

DATA ID	MAX	MIN	T1	T2	CH
TIME OF EVENT			203.00		37
2.5V EXT PWR	2.50	2.49	307.00	39.00	47
10V EXT PWR	10.01	9.98	12.00	249.00	48
SHD PLD PRIOR EVENT	21.74		100.00	200.00	
LF LAP PLD PRIOR EVENT	46.03		100.00	200.00	
RT LAP PLD PRIOR EVENT	38.28		100.00	200.00	
SLED X ACCEL	1.57	-40.40	450.00	363.00	1
SLED X ACCEL (SM)	1.30	-40.04	500.00	362.00	
SLED Y ACCEL	2.22	-0.77	394.00	700.00	2
SLED Z ACCEL	3.66	-2.52	506.00	449.00	3
SLED VEL (INT ACCEL)	0.02	-105.98	268.00	429.00	
SLED VELOCITY	0.15	-105.53	238.00	467.00	29
VEL AT EVENT		-105.53		467.00	
SHOULDER LOAD X	4189.18	-34.09	349.00	480.00	23
SHOULDER LOAD Y	156.14	-11.23	347.00	427.00	22
SHOULDER LOAD Z	1041.20	-12.31	350.00	462.00	21
SHOULDER RESULTANT	4316.46	2.65	349.00	533.00	
LF LAP LOAD X	2745.53	-21.22	351.00	694.00	15
LF LAP LOAD Y	1441.27	-10.79	351.00	752.00	16
LF LAP LOAD Z	2834.82	-20.26	350.00	780.00	17
LF LAP RESULTANT	4064.15	1.69	350.00	565.00	
RT LAP LOAD X	2744.05	-32.61	350.00	717.00	18
RT LAP LOAD Y	1327.52	-7.10	350.00	728.00	19
RT LAP LOAD Z	2921.60	-22.76	349.00	709.00	20
RT LAP RESULTANT	4205.23	3.09	349.00	689.00	

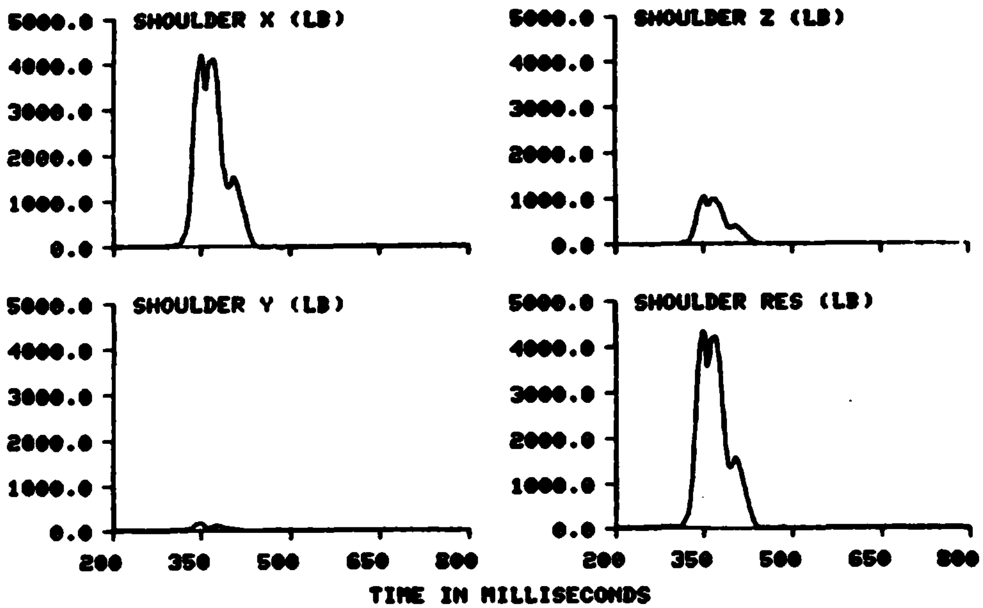

HBUX LAP BELT STUDY
TEST NO: 2028
SUBJ ID: 95%
SLED X (G)
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
SLED Y (G)
10.0
5.0
0.0
-5.0
-10.0
SLED Z (G)
10.0
5.0
0.0
-5.0
-10.0
200
350
500
650
800
200
350
500
650
800
TIME IN MILLISECONDS


HBUX LAP BELT STUDY
TEST NO: 2028
SUBJ ID: 95%
SLED INT VEL (F/S)
20.0
0.0
-20.0
-40.0
-60.0
-80.0
-100.0
SLED VELOCITY (F/S)
20.0
0.0
-20.0
-40.0
-60.0
-80.0
-100.0
200
350
500
650
800
TIME IN MILLISECONDS


HBUX LAP BELT STUDY
TEST NO: 2028
SUBJ ID: 95%
LF LAP X (LB)
LF LAP Z (LB)
LF LAP Y (LB)
LF LAP RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
200
350
500
650
800
TIME IN MILLISECONDS

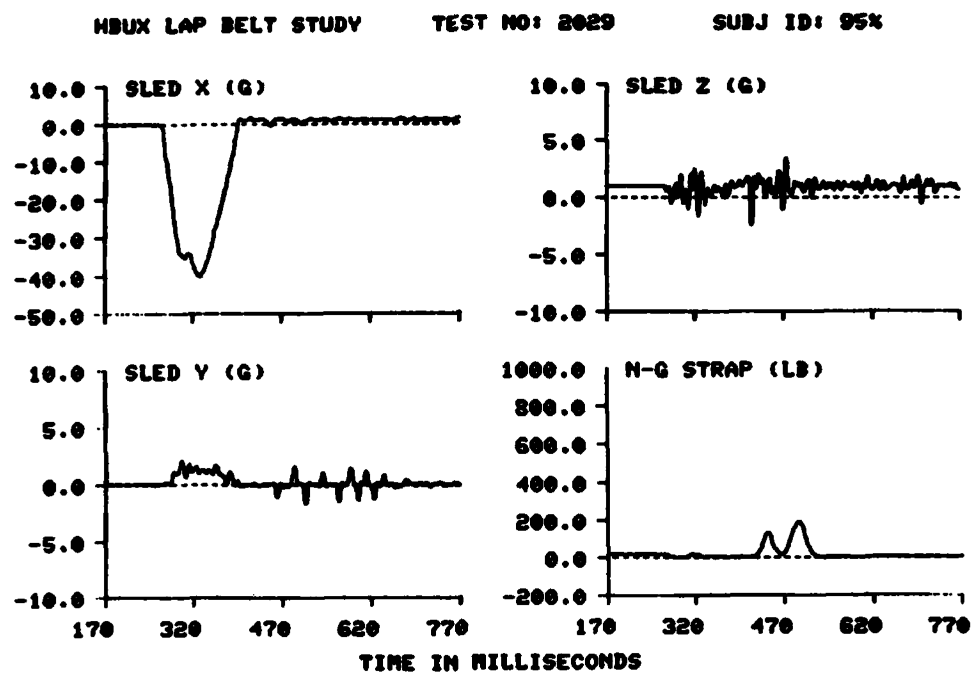

HBUX LAP BELT STUDY
TEST NO: 2028
SUBJ ID: 95%
RT LAP X (LB)
RT LAP Z (LB)
RT LAP Y (LB)
RT LAP RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
200
350
500
650
800
TIME IN MILLISECONDS

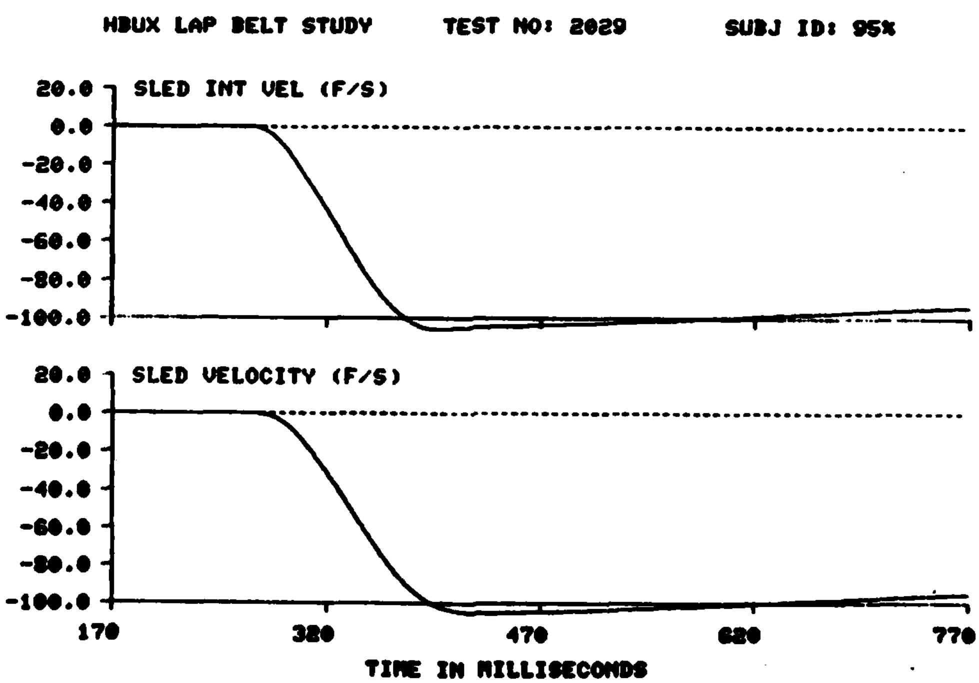
HBUX LAP BELT STUDY   TEST NO: 2028   SUBJ ID: 95%

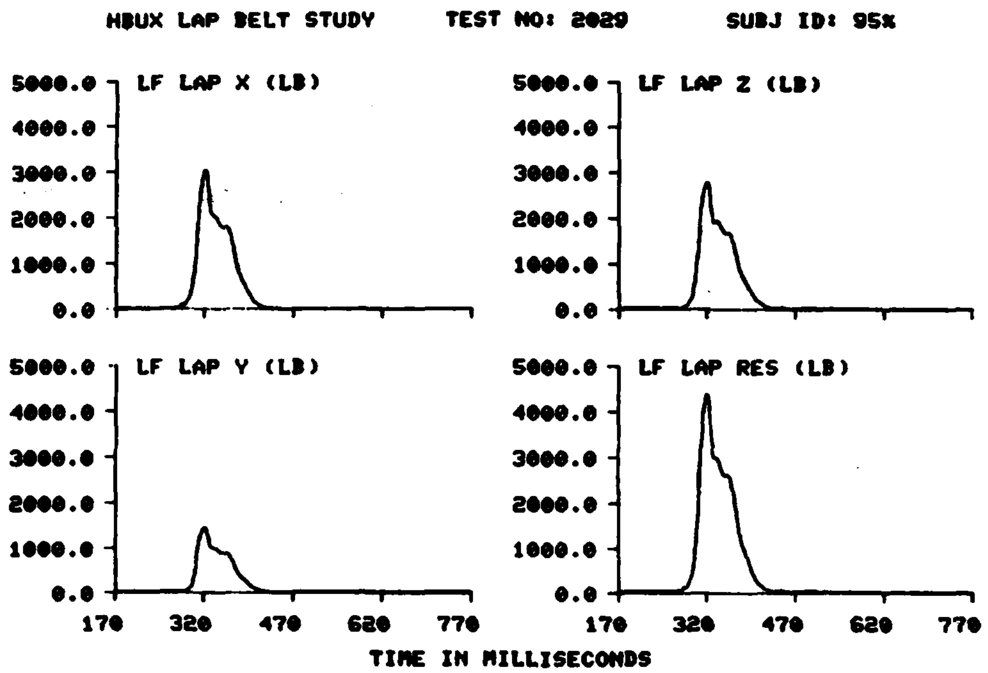


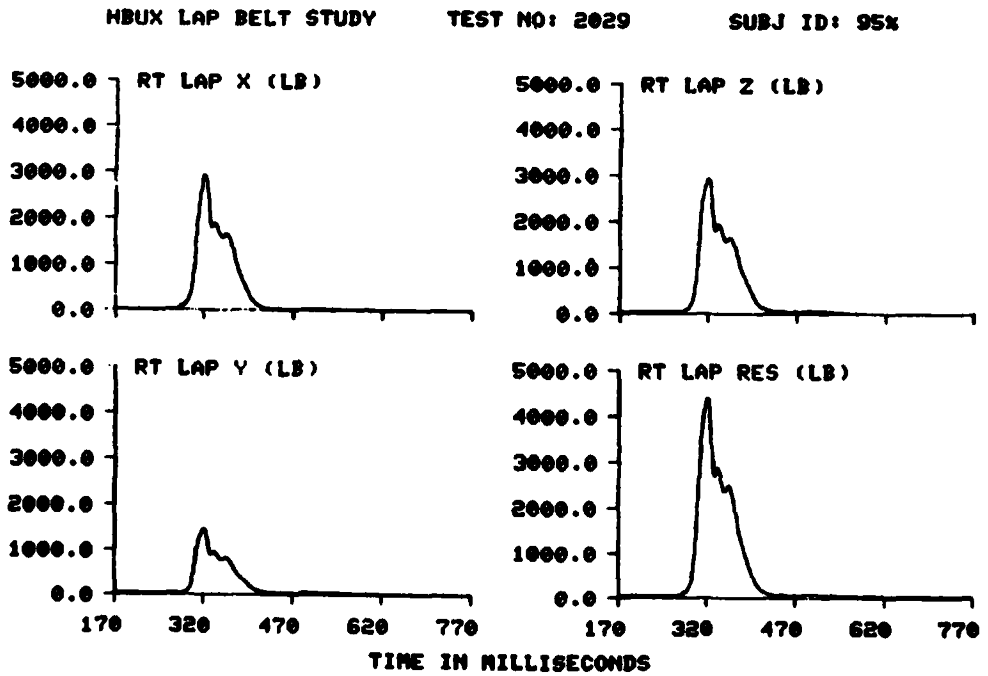
HBUX LAP BELT STUDY TEST: 2029 SUBJ: 95% WT: 204.0 NOM G: 40.0 CELL: X

DATA ID	MAX	MIN	T1	T2	CH
TIME OF EVENT			174.00		37
2.5V EXT PWR	2.51	2.49	210.00	369.00	47
10V EXT PWR	10.02	9.98	407.00	50.00	48
SHD PLD PRIOR EVENT	31.74		70.00	170.00	
LF LAP PLD PRIOR EVENT	34.59		70.00	170.00	
RT LAP PLD PRIOR EVENT	28.51		70.00	170.00	
SLED X ACCEL	1.66	-40.13	417.00	331.00	1
SLED X ACCEL (SM)	1.34	-39.83	467.00	331.00	
SLED Y ACCEL	2.13	-1.67	299.00	509.00	2
SLED Z ACCEL	3.51	-2.44	475.00	417.00	3
N-G STRAP	193.16	-2.97	494.00	539.00	30
SLED VEL (INT ACCEL)	0.00	-105.67	170.00	396.00	
SLED VELOCITY	0.26	-105.61	274.00	495.00	29
VEL AT EVENT		-105.61		435.00	
SHOULDER LOAD X	4506.46	-26.70	318.00	449.00	23
SHOULDER LOAD Y	210.47	-21.79	316.00	355.00	22
SHOULDER LOAD Z	1103.72	-10.61	319.00	468.00	21
SHOULDER RESULTANT	4642.40	1.42	318.00	687.00	
LF LAP LOAD X	3047.19	-17.06	321.00	476.00	15
LF LAP LOAD Y	1446.57	-5.49	321.00	477.00	16
LF LAP LOAD Z	2773.73	-5.61	320.00	609.00	17
LF LAP RESULTANT	4367.10	3.60	321.00	462.00	
RT LAP LOAD X	2935.49	-22.92	320.00	632.00	18
RT LAP LOAD Y	1453.12	-8.37	320.00	549.00	19
RT LAP LOAD Z	2920.61	-19.63	321.00	663.00	20
RT LAP RESULTANT	4388.47	2.64	321.00	571.00	

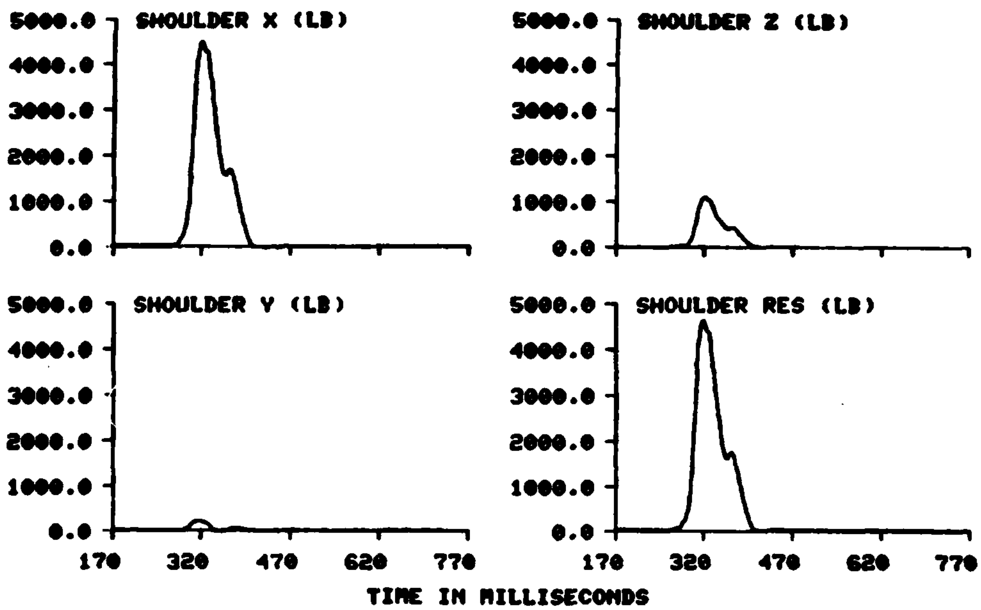

HBUX LAP BELT STUDY
TEST NO: 2029
SUBJ ID: 95%
SLED X (G)
SLED Z (G)
SLED Y (G)
N-G STRAP (LB)
TIME IN MILLISECONDS


HBUX LAP BELT STUDY
TEST NO: 2029
SUBJ ID: 95%
SLED INT VEL (F/S)
SLED VELOCITY (F/S)
TIME IN MILLISECONDS


HBUX LAP BELT STUDY
TEST NO: 2029
SUBJ ID: 95%
LF LAP X (LB)
LF LAP Z (LB)
LF LAP Y (LB)
LF LAP RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
170
320
470
620
770
TIME IN MILLISECONDS


HBUX LAP BELT STUDY
TEST NO: 2029
SUBJ ID: 95%
RT LAP X (LB)
RT LAP Z (LB)
RT LAP Y (LB)
RT LAP RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
170
320
470
620
770
TIME IN MILLISECONDS

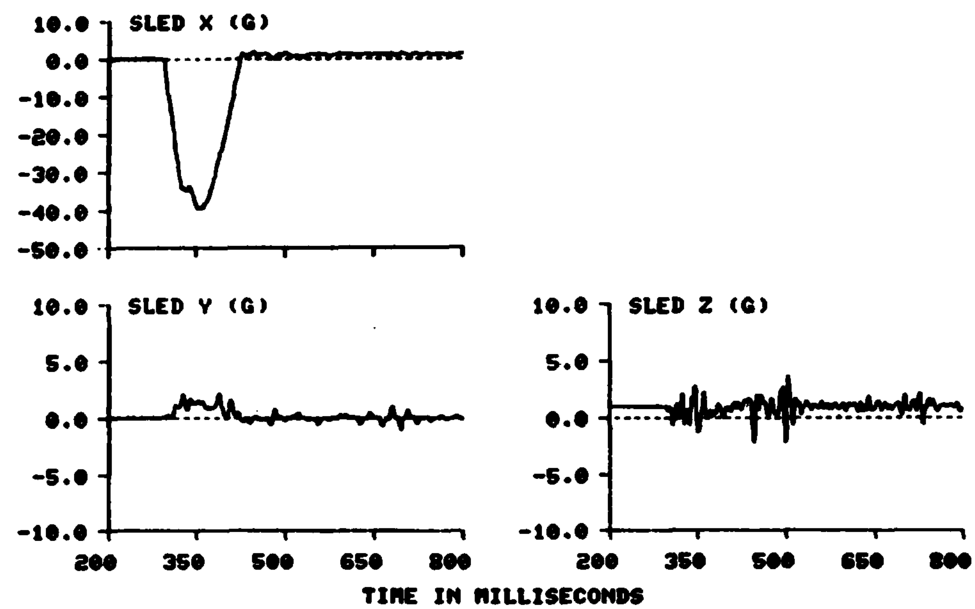
HBUX LAP BELT STUDY TEST NO: 2029 SUBJ ID: 95%



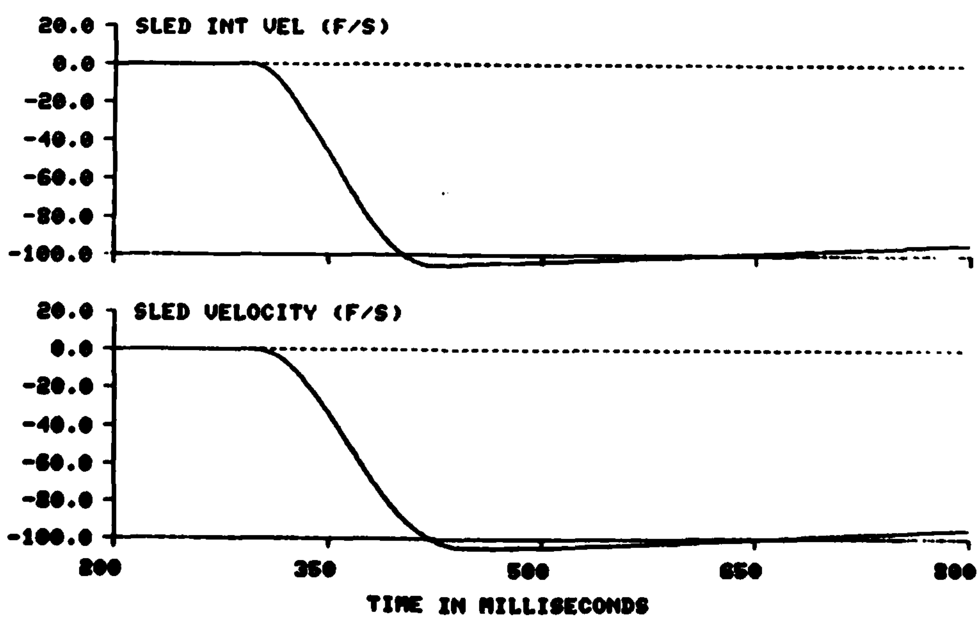
HBUX LAP BELT STUDY TEST: 2030 SUBJ: 95% WT: 204.0 NOM G: 40.0 CELL: X

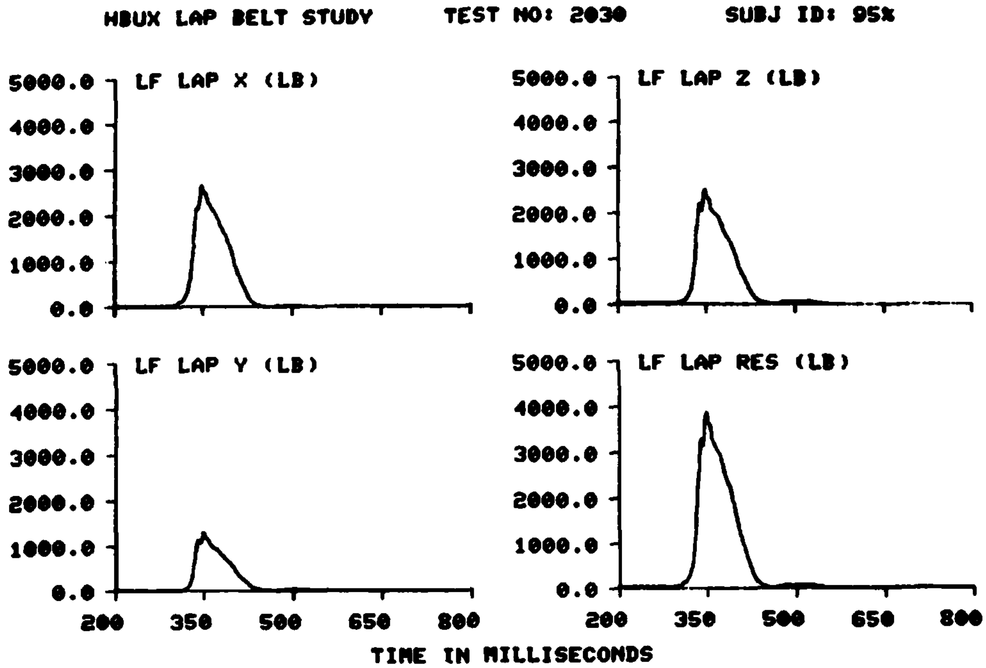
DATA ID	MAX	MIN	T1	T2	CH
TIME OF EVENT			204.00		37
2.5V EXT PWR	2.50	2.49	1.00	202.00	47
10V EXT PWR	10.03	9.98	73.00	86.00	48
SHD PLD PRIOR EVENT	25.21		100.00	200.00	
LF LAP PLD PRIOR EVENT	36.59		100.00	200.00	
RT LAP PLD PRIOR EVENT	34.49		100.00	200.00	
SLED X ACCEL	1.74	-39.62	500.00	354.00	1
SLED X ACCEL (SM)	1.95	-39.40	445.00	355.00	
SLED Y ACCEL	2.17	-1.06	388.00	695.00	2
SLED Z ACCEL	3.72	-2.18	504.00	499.00	3
SLED VEL (INT ACCEL)	0.01	-105.66	208.00	424.00	
SLED VELOCITY	0.20	-105.55	221.00	465.00	29
VEL AT EVENT		-105.55		465.00	
SHOULDER LOAD X	4176.87	-26.54	357.00	482.00	23
SHOULDER LOAD Y	154.27	-27.89	334.00	419.00	22
SHOULDER LOAD Z	1079.75	-11.39	346.00	498.00	21
SHOULDER RESULTANT	4313.48	1.60	358.00	516.00	
LF LAP LOAD X	2651.52	-25.98	347.00	668.00	15
LF LAP LOAD Y	1305.64	-12.71	348.00	624.00	16
LF LAP LOAD Z	2532.16	-18.90	347.00	659.00	17
LF LAP RESULTANT	3891.14	1.91	347.00	565.00	
RT LAP LOAD X	2161.86	-19.08	337.00	720.00	18
RT LAP LOAD Y	1180.36	-14.41	337.00	616.00	19
RT LAP LOAD Z	2476.07	-14.68	337.00	636.00	20
RT LAP RESULTANT	3485.83	2.28	337.00	571.00	

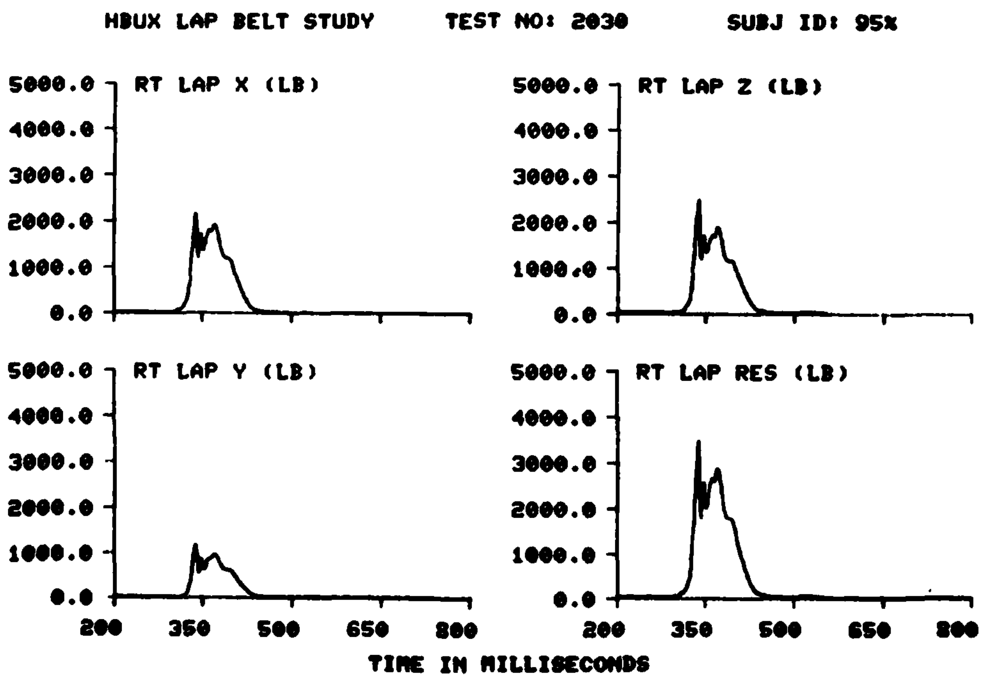
HBUX LAP BELT STUDY   TEST NO: 2030   SUBJ ID: 95%

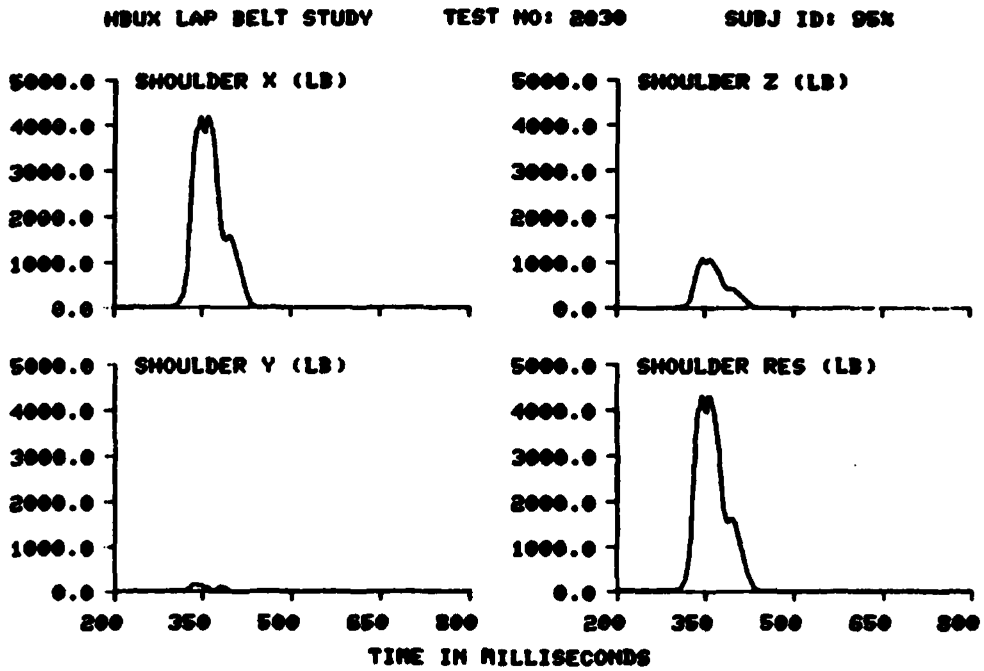


HBUX LAP BELT STUDY   TEST NO: 2030   SUBJ ID: 95%




HBUX LAP BELT STUDY
TEST NO: 2030
SUBJ ID: 95%
LF LAP X (LB)
LF LAP Z (LB)
LF LAP Y (LB)
LF LAP RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
200
350
500
650
800
TIME IN MILLISECONDS

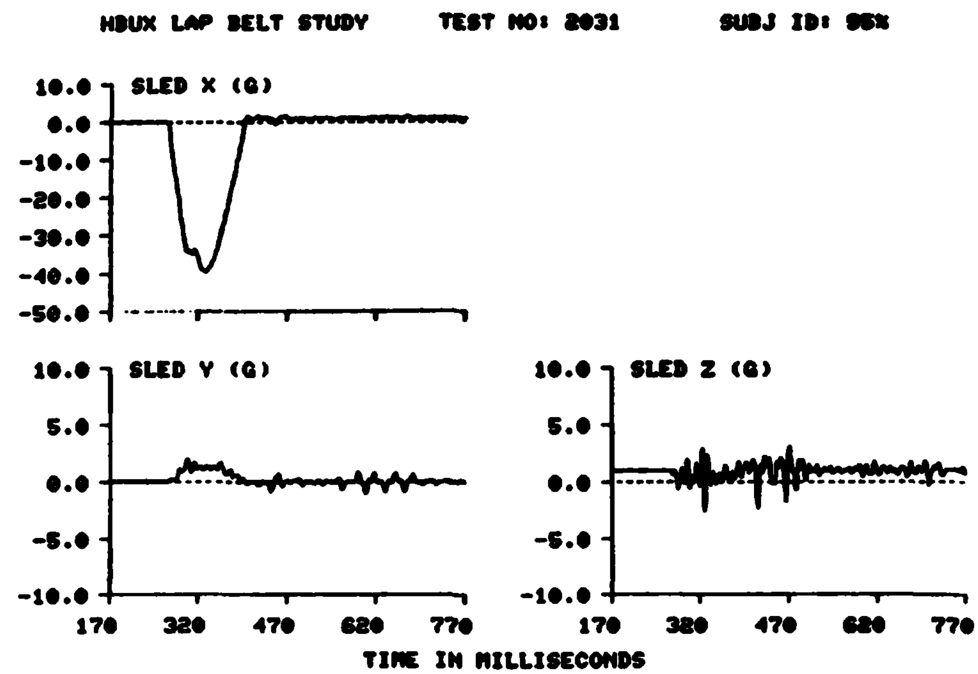

HBUX LAP BELT STUDY
TEST NO: 2030
SUBJ ID: 95%
RT LAP X (LB)
RT LAP Z (LB)
RT LAP Y (LB)
RT LAP RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
200
350
500
650
800
TIME IN MILLISECONDS

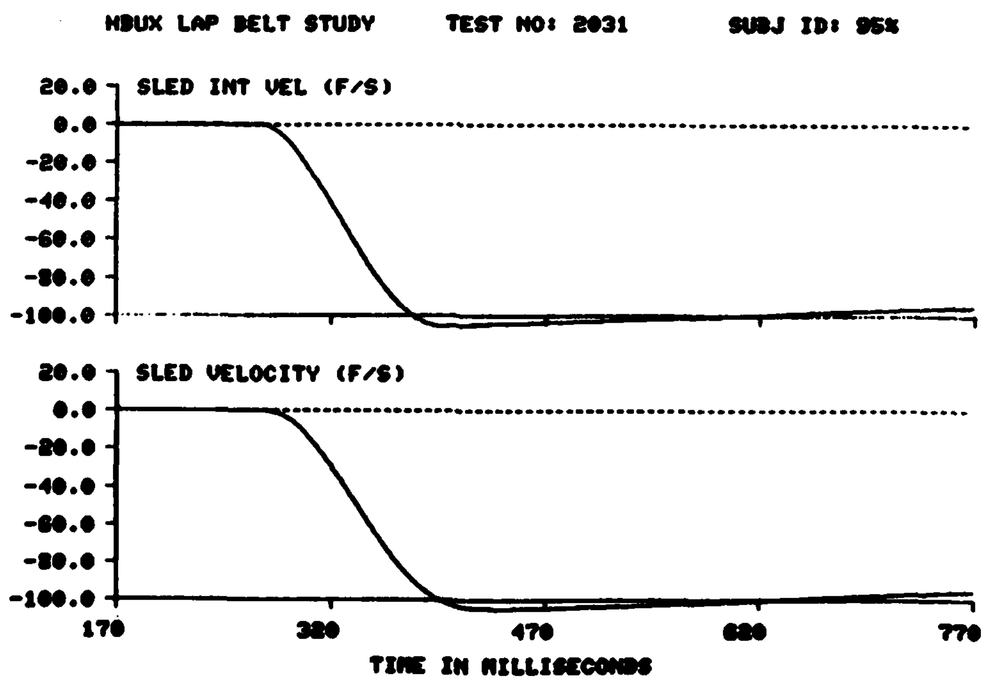


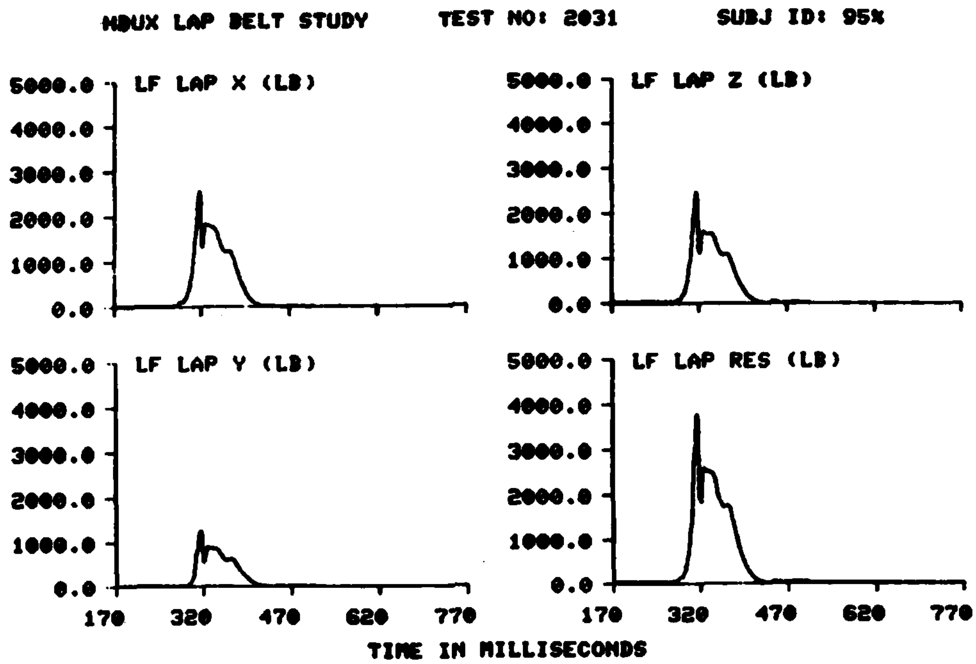
HBUX LAP BELT STUDY
TEST NO: 2030
SUBJ ID: 95%
SHOULDER X (LB)
SHOULDER Z (LB)
SHOULDER Y (LB)
SHOULDER RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
200
350
500
650
800
TIME IN MILLISECONDS

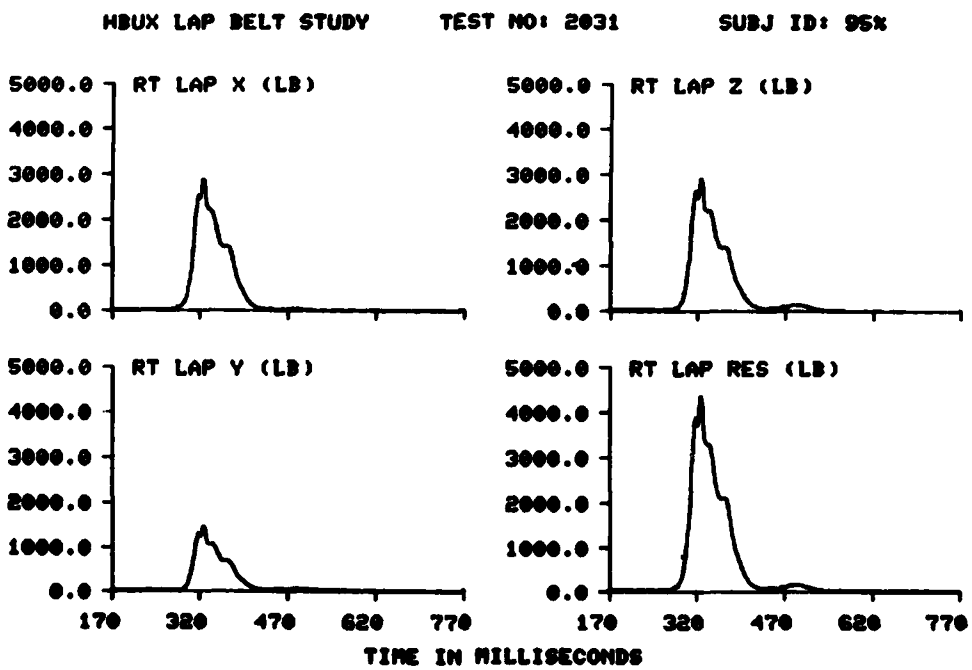
MBUX LAP BELT STUDY TEST: 2031 SUBJ: 95% WT: 204.0 NOM G: 40.0 CELL: X

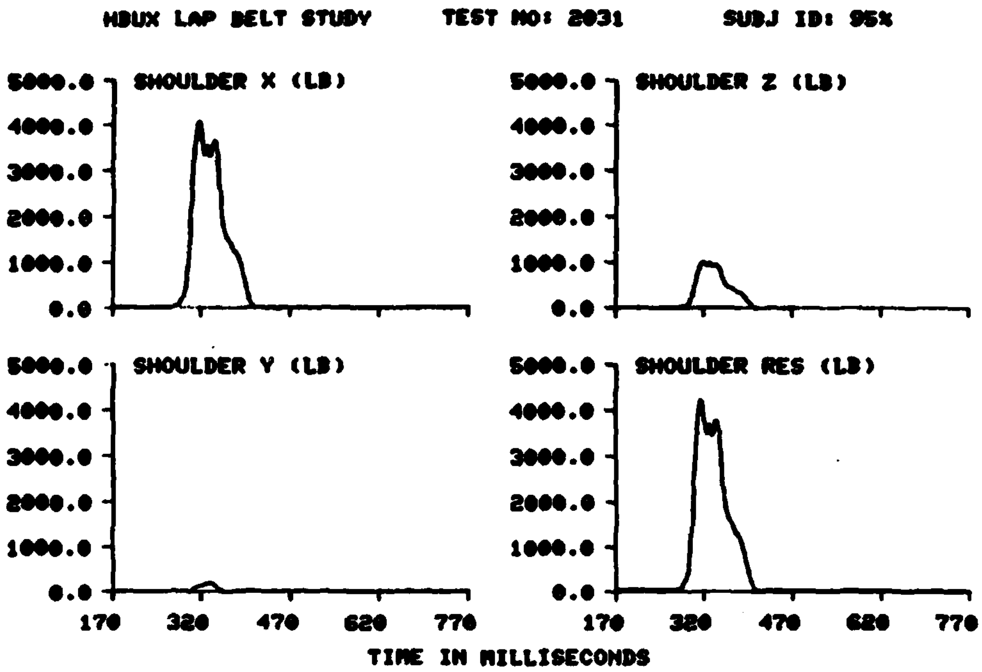
DATA ID	MAX	MIN	T1	T2	CH
TIME OF EVENT			170.00		37
2.5V EXT PWR	2.51	2.49	403.00	53.00	47
10V EXT PWR	10.01	9.98	43.00	42.00	48
SHD PLD PRIOR EVENT	22.49		70.00	170.00	
LF LAP PLD PRIOR EVENT	32.22		70.00	170.00	
RT LAP PLD PRIOR EVENT	32.14		70.00	170.00	
SLED X ACCEL	1.59	-39.66	418.00	331.00	1
SLED X ACCEL (SM)	1.37	-39.22	464.00	331.00	
SLED Y ACCEL	1.99	-1.08	301.00	604.00	2
SLED Z ACCEL	3.14	-2.57	472.00	328.00	3
SLED VEL (INT ACCEL)	0.00	-105.41	170.00	398.00	
SLED VELOCITY	0.20	-105.19	261.00	440.00	29
VEL AT EVENT		-105.19		440.00	
SHOULDER LOAD X	4089.38	-30.59	315.00	450.00	23
SHOULDER LOAD Y	177.98	-26.96	333.00	365.00	22
SHOULDER LOAD Z	1006.89	-10.12	319.00	464.00	21
SHOULDER RESULTANT	4206.69	1.31	316.00	517.00	
LF LAP LOAD X	2574.56	-23.60	316.00	747.00	15
LF LAP LOAD Y	1270.54	-7.93	315.00	194.00	16
LF LAP LOAD Z	2472.41	-14.58	315.00	577.00	17
LF LAP RESULTANT	3772.06	2.07	315.00	529.00	
RT LAP LOAD X	2894.20	-28.88	326.00	689.00	18
RT LAP LOAD Y	1460.73	-10.91	326.00	559.00	19
RT LAP LOAD Z	2930.67	-17.81	326.00	655.00	20
RT LAP RESULTANT	4370.24	2.63	326.00	642.00	


HBUX LAP BELT STUDY
TEST NO: 2031
SUBJ ID: 95%
SLED X (G)
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
SLED Y (G)
10.0
5.0
0.0
-5.0
-10.0
SLED Z (G)
170
320
470
620
770
TIME IN MILLISECONDS


HBUX LAP BELT STUDY
TEST NO: 2031
SUBJ ID: 95%
SLED INT VEL (F/S)
20.0
0.0
-20.0
-40.0
-60.0
-80.0
-100.0
SLED VELOCITY (F/S)
170
320
470
620
770
TIME IN MILLISECONDS


HBUX LAP BELT STUDY
TEST NO: 2031
SUBJ ID: 95%
LF LAP X (LB)
LF LAP Z (LB)
LF LAP Y (LB)
LF LAP RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
170
320
470
620
770
TIME IN MILLISECONDS

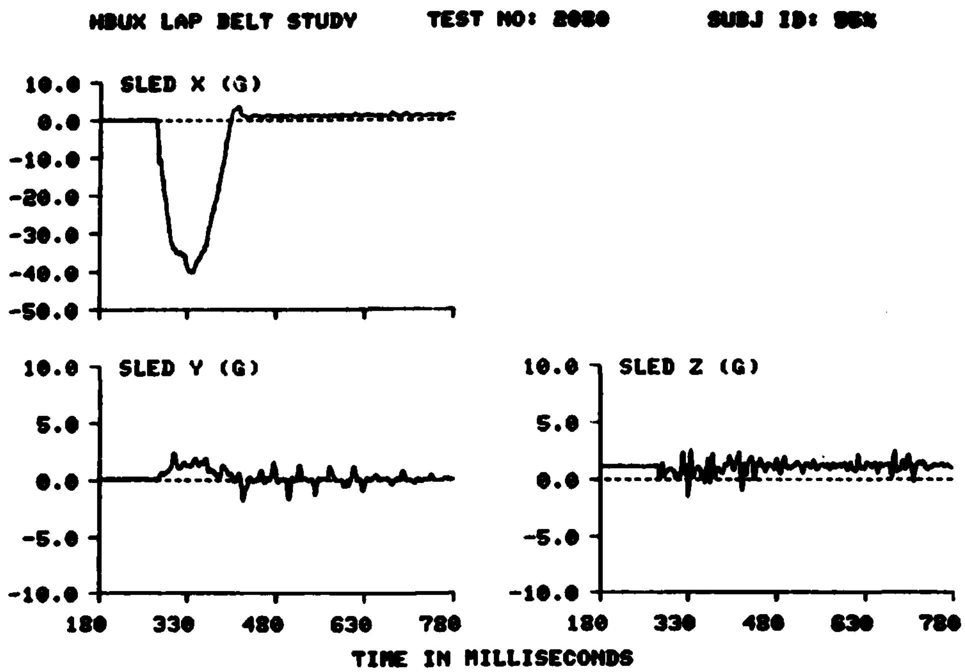

HBUX LAP BELT STUDY
TEST NO: 2031
SUBJ ID: 95%
RT LAP X (LB)
RT LAP Z (LB)
RT LAP Y (LB)
RT LAP RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
170
320
470
620
770
TIME IN MILLISECONDS

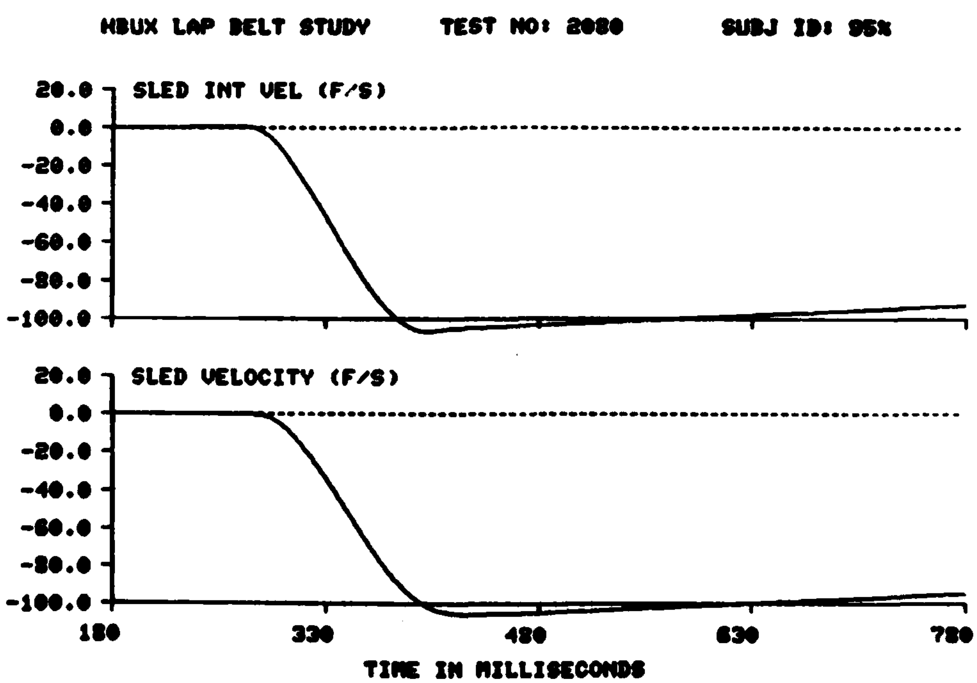


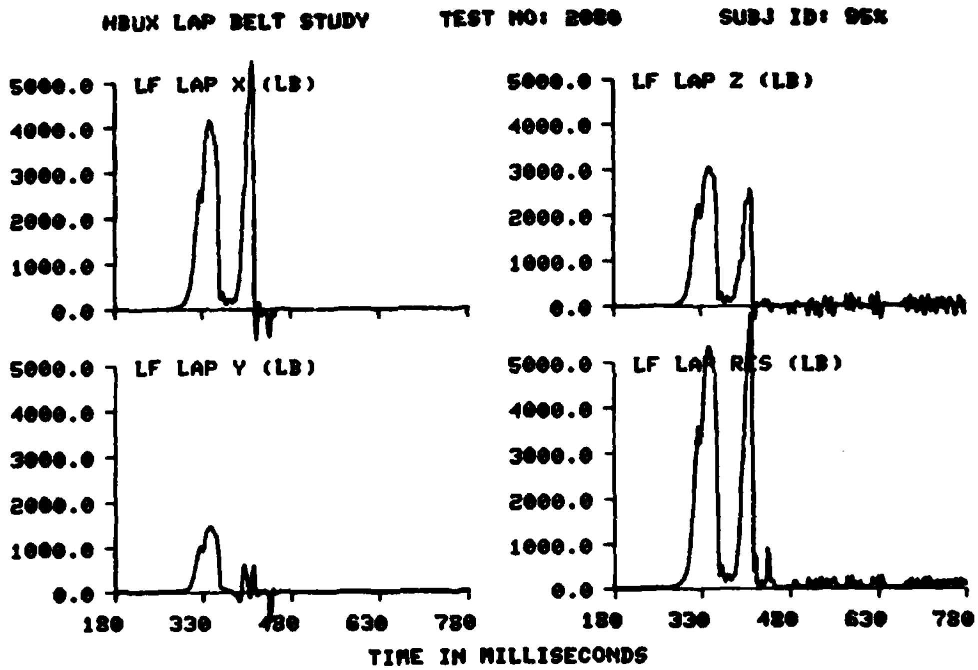
HBUX LAP BELT STUDY
TEST NO: 2031
SUBJ ID: 95%
SHOULDER X (LB)
SHOULDER Z (LB)
SHOULDER Y (LB)
SHOULDER RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
170
320
470
620
770
TIME IN MILLISECONDS

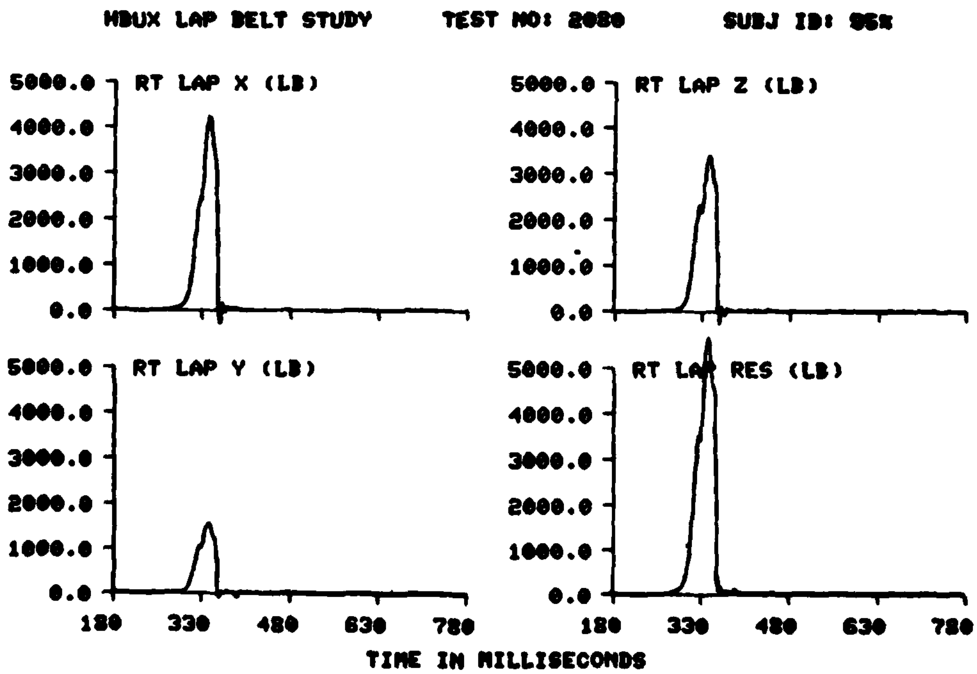
MBUX LAP BELT STUDY TEST: 2080 SUBJ: 95% WT: 204.0 NOM G: 40.0 CELL: X

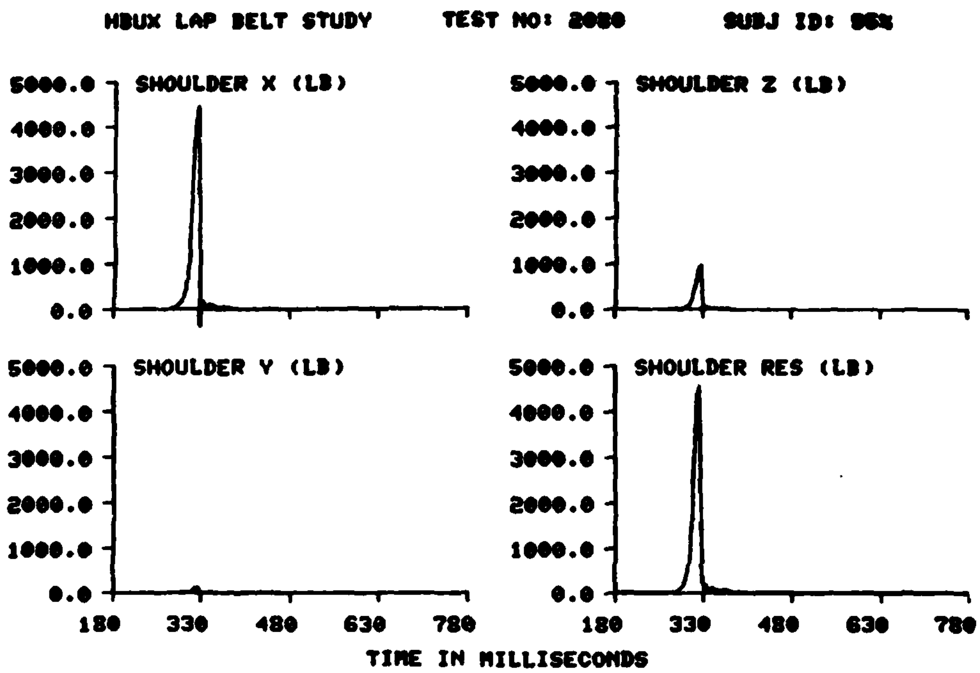
DATA ID	MAX	MIN	T1	T2	CH
TIME OF EVENT			182.00		37
2.5V EXT PWR	2.50	2.49	227.00	15.00	47
10V EXT PWR	10.01	9.98	548.00	65.00	48
SHD PLD PRIOR EVENT	10.89		80.00	180.00	
LF LAP PLD PRIOR EVENT	24.87		80.00	180.00	
RT LAP PLD PRIOR EVENT	17.74		80.00	180.00	
SLED X ACCEL	3.54	-40.24	415.00	337.00	1
SLED X ACCEL (SM)	3.08	-39.85	419.00	337.00	
SLED Y ACCEL	2.38	-1.88	307.00	424.00	2
SLED Z ACCEL	2.63	-1.52	334.00	330.00	3
SLED VEL (INT ACCEL)	0.12	-106.57	278.00	402.00	
SLED VELOCITY	0.15	-106.24	214.00	438.00	29
VEL AT EVENT		-106.24		438.00	
SHOULDER LOAD X	4450.44	-356.85	322.00	329.00	23
SHOULDER LOAD Y	118.43	-21.61	322.00	328.00	22
SHOULDER LOAD Z	970.64	-75.57	323.00	329.00	21
SHOULDER RESULTANT	4548.97	1.33	322.00	775.00	
LF LAP LOAD X	5515.35	-652.81	415.00	421.00	15
LF LAP LOAD Y	1469.51	-665.18	342.00	443.00	16
LF LAP LOAD Z	3081.75	-282.28	343.00	421.00	17
LF LAP RESULTANT	6094.75	7.70	415.00	619.00	
RT LAP LOAD X	4252.84	-285.84	342.00	359.00	18
RT LAP LOAD Y	1554.97	-106.97	341.00	389.00	19
RT LAP LOAD Z	3407.14	-287.14	342.00	359.00	20
RT LAP RESULTANT	5665.46	5.17	342.00	636.00	


HBUX LAP BELT STUDY
TEST NO: 2080
SUBJ ID: 95%
SLED X (G)
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
SLED Y (G)
SLED Z (G)
10.0
5.0
0.0
-5.0
-10.0
180
330
480
630
780
TIME IN MILLISECONDS


HBUX LAP BELT STUDY
TEST NO: 2080
SUBJ ID: 95%
SLED INT VEL (F/S)
SLED VELOCITY (F/S)
20.0
0.0
-20.0
-40.0
-60.0
-80.0
-100.0
180
330
480
630
780
TIME IN MILLISECONDS


HBUX LAP BELT STUDY
TEST NO: 2080
SUBJ ID: 95%
LF LAP X (LB)
LF LAP Z (LB)
LF LAP Y (LB)
LF LAP RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
180
330
480
630
780
TIME IN MILLISECONDS

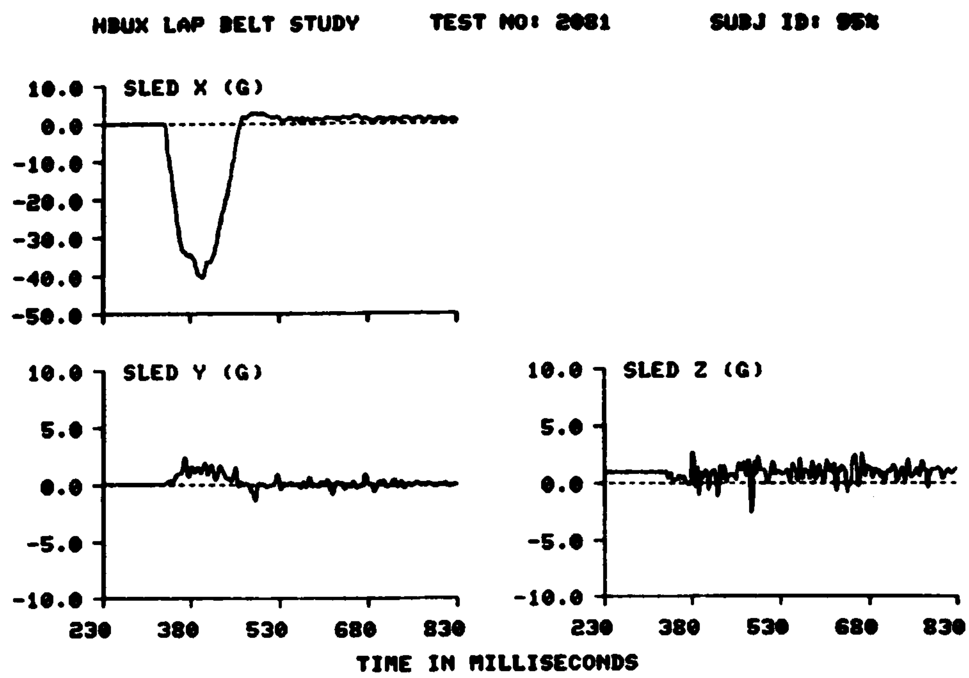

HBUX LAP BELT STUDY
TEST NO: 2080
SUBJ ID: 95%
RT LAP X (LB)
RT LAP Z (LB)
RT LAP Y (LB)
RT LAP RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
180
330
480
630
780
TIME IN MILLISECONDS

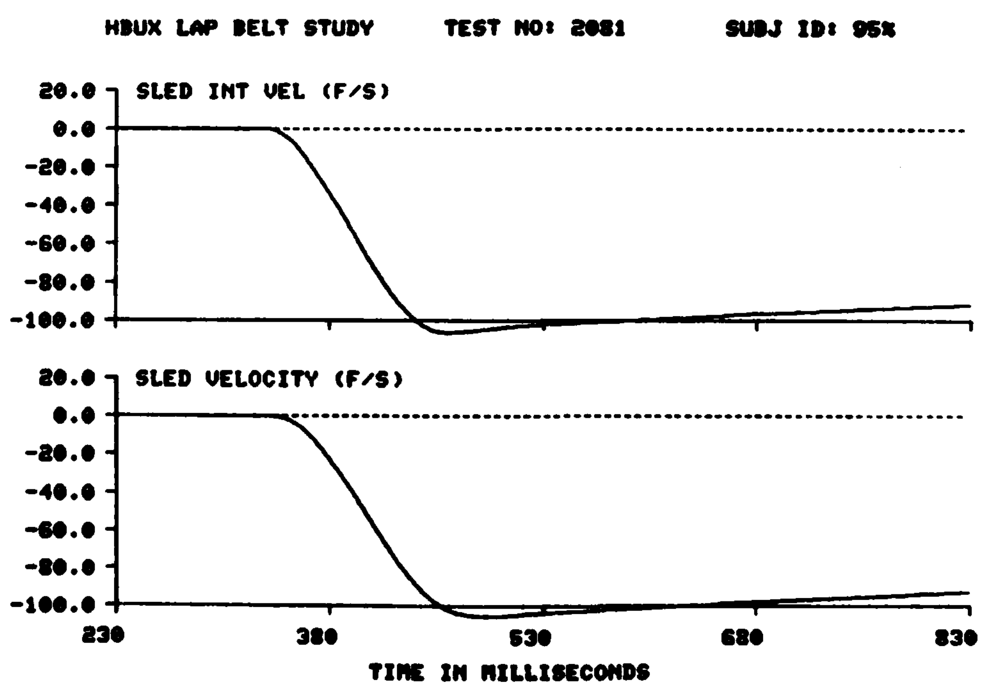


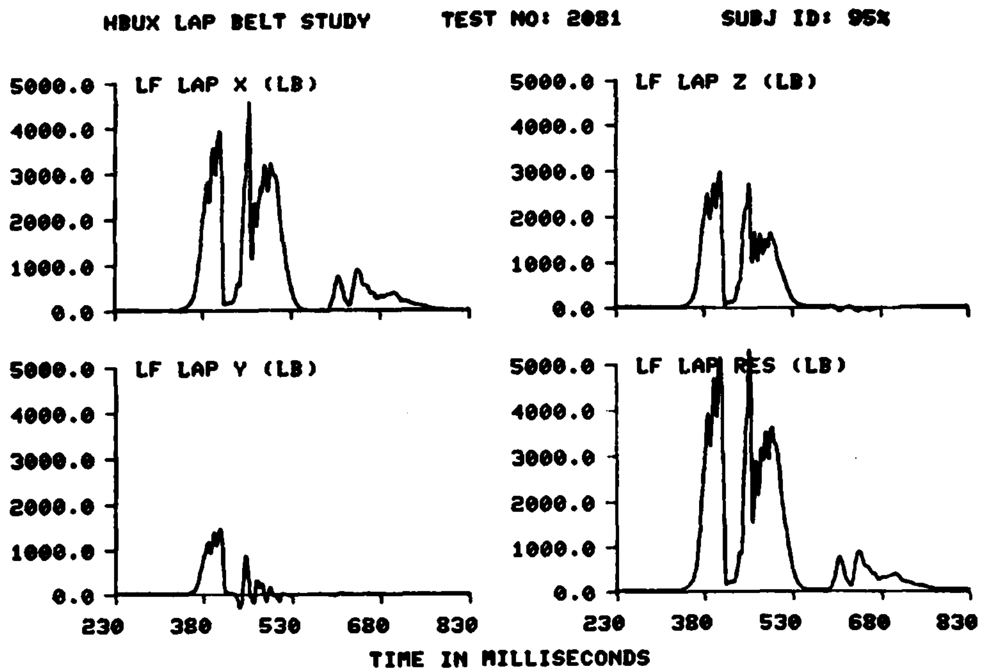
HBUX LAP BELT STUDY
TEST NO: 2080
SUBJ ID: 95%
SHOULDER X (LB)
SHOULDER Z (LB)
SHOULDER Y (LB)
SHOULDER RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
180
330
480
630
780
TIME IN MILLISECONDS

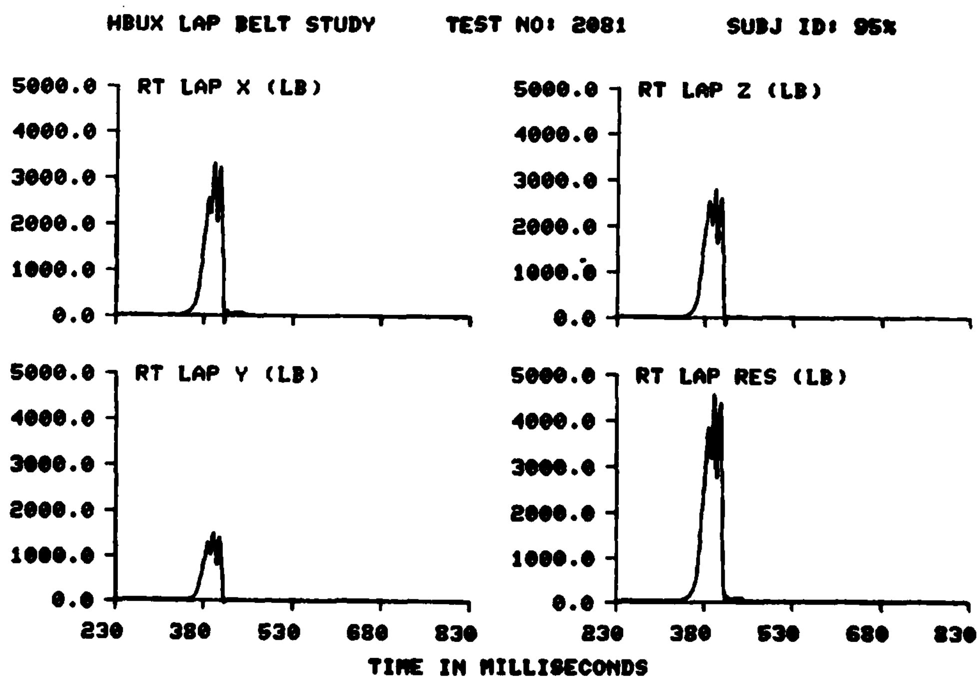
HBUX LAP BELT STUDY TEST: 2081 SUBJ: 95% WT: 204.0 NOM G: 40.0 CELL: X

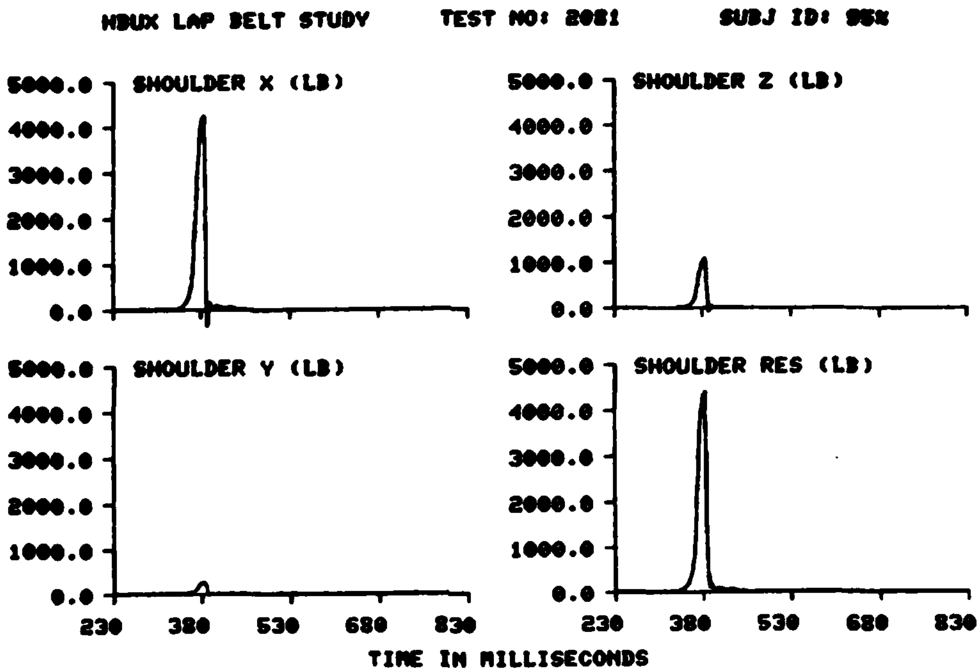
DATA ID	MAX	MIN	T1	T2	CH
TIME OF EVENT			234.00		37
2.5V EXT PWR	2.50	2.49	3.00	50.00	47
10V EXT PWR	10.01	9.98	400.00	217.00	48
SHO PLD PRIOR EVENT	14.92		130.00	230.00	
LF LAP PLD PRIOR EVENT	20.68		130.00	230.00	
RT LAP PLD PRIOR EVENT	22.86		130.00	230.00	
SLED X ACCEL	2.71	-40.59	489.00	399.00	1
SLED X ACCEL (SM)	2.57	-40.10	486.00	398.00	
SLED Y ACCEL	2.41	-1.38	369.00	488.00	2
SLED Z ACCEL	2.68	-2.59	381.00	481.00	3
SLED VEL (INT ACCEL)	0.00	-106.27	232.00	463.00	
SLED VELOCITY	0.24	-105.86	279.00	493.00	29
VEL AT EVENT		-105.86		493.00	
SHOULDER LOAD X	4253.94	-370.60	383.00	390.00	23
SHOULDER LOAD Y	254.51	-26.71	382.00	391.00	22
SHOULDER LOAD Z	1099.15	-85.74	384.00	391.00	21
SHOULDER RESULTANT	4395.00	1.36	383.00	481.00	
LF LAP LOAD X	4582.39	-13.98	457.00	820.00	15
LF LAP LOAD Y	1456.61	-309.79	406.00	439.00	16
LF LAP LOAD Z	2979.58	-76.09	407.00	610.00	17
LF LAP RESULTANT	5325.54	12.39	457.00	284.00	
RT LAP LOAD X	3317.86	-165.59	396.00	414.00	18
RT LAP LOAD Y	1491.48	-66.43	396.00	414.00	19
RT LAP LOAD Z	2764.61	-172.13	396.00	414.00	20
RT LAP RESULTANT	4581.14	1.54	396.00	512.00	


HBUX LAP BELT STUDY
TEST NO: 2081
SUBJ ID: 95%
SLED X (G)
SLED Y (G)
SLED Z (G)
TIME IN MILLISECONDS


HBUX LAP BELT STUDY
TEST NO: 2081
SUBJ ID: 95%
SLED INT VEL (F/S)
SLED VELOCITY (F/S)
TIME IN MILLISECONDS


HBUX LAP BELT STUDY
TEST NO: 2081
SUBJ ID: 95%
LF LAP X (LB)
LF LAP Z (LB)
LF LAP Y (LB)
LF LAP RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
230
380
530
680
830
TIME IN MILLISECONDS

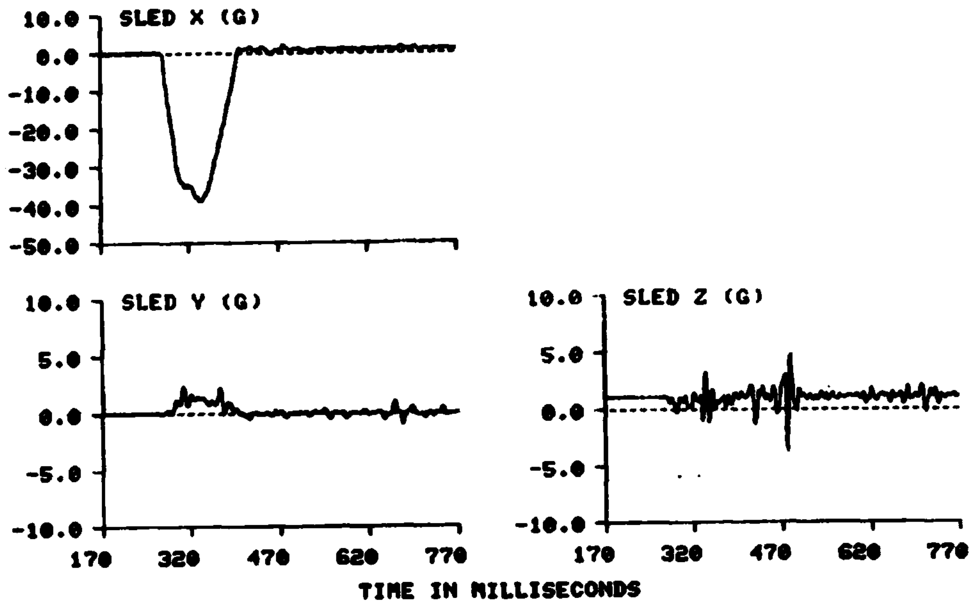

HBUX LAP BELT STUDY
TEST NO: 2081
SUBJ ID: 95%
RT LAP X (LB)
RT LAP Z (LB)
RT LAP Y (LB)
RT LAP RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
230
380
530
680
830
TIME IN MILLISECONDS


HBUX LAP BELT STUDY
TEST NO: 2081
SUBJ ID: 95%
SHOULDER X (LB)
SHOULDER Z (LB)
SHOULDER Y (LB)
SHOULDER RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
230
380
530
680
830
TIME IN MILLISECONDS

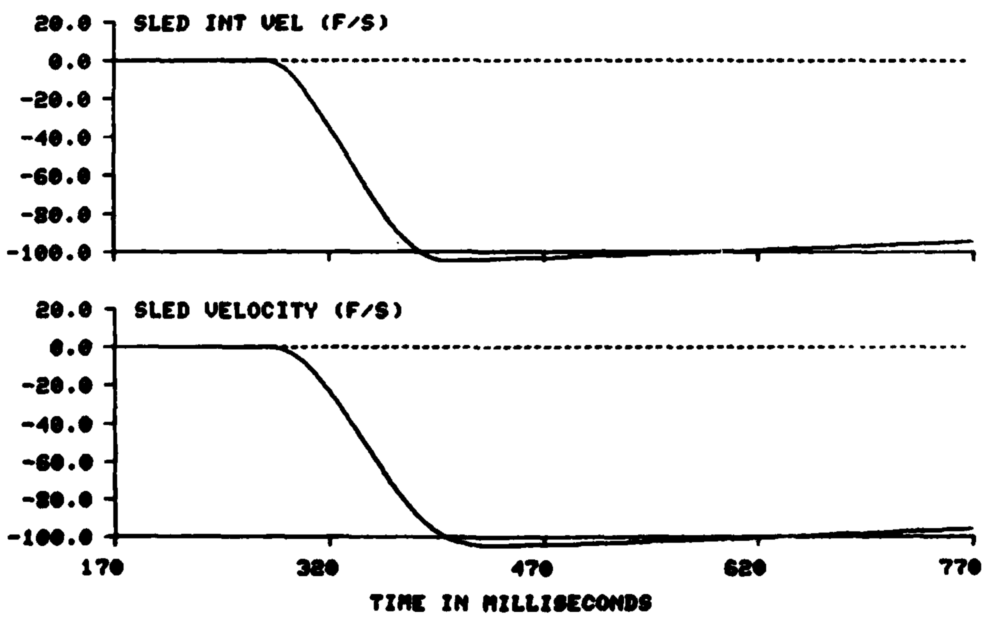
MBUX LAP BELT STUDY TEST: 2082 SUBJ: 95% WT: 204.0 NOM G: 40.0 CELL: X

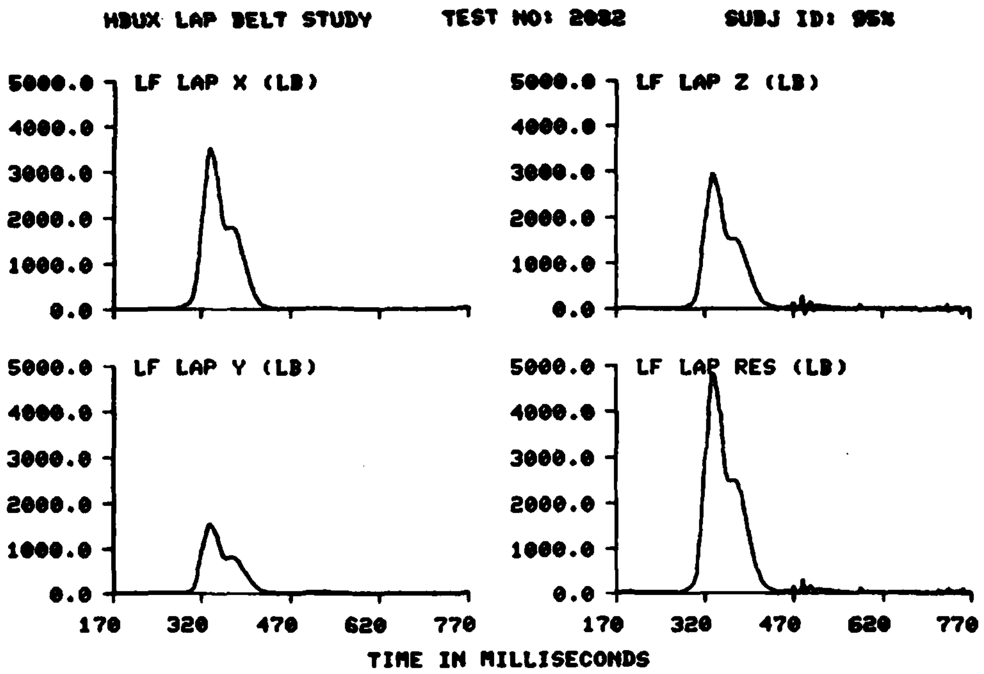
DATA ID	MAX	MIN	T1	T2	CH
TIME OF EVENT			172.00		37
2.5V EXT PWR	2.50	2.49	8.00	79.00	47
10V EXT PWR	10.01	9.98	263.00	19.00	48
SHD PLD PRIOR EVENT	14.72		70.00	170.00	
LF LAP PLD PRIOR EVENT	22.49		70.00	170.00	
RT LAP PLD PRIOR EVENT	22.85		70.00	170.00	
SLED X ACCEL	1.91	-38.86	480.00	338.00	1
SLED X ACCEL (SM)	1.44	-38.60	480.00	340.00	
SLED Y ACCEL	2.40	-0.99	308.00	678.00	2
SLED Z ACCEL	4.77	-3.73	485.00	480.00	3
SLED VEL (INT ACCEL)	0.03	-104.83	266.00	403.00	
SLED VELOCITY	0.23	-104.99	180.00	439.00	29
VEL AT EVENT		-104.99		439.00	
SHOULDER LOAD X	4392.92	-29.00	324.00	460.00	23
SHOULDER LOAD Y	198.83	-9.52	346.00	561.00	22
SHOULDER LOAD Z	1134.09	-11.87	328.00	479.00	21
SHOULDER RESULTANT	4529.90	1.29	325.00	591.00	
LF LAP LOAD X	3511.79	-13.59	334.00	634.00	15
LF LAP LOAD Y	1526.56	-7.60	334.00	640.00	16
LF LAP LOAD Z	2947.54	-120.14	333.00	489.00	17
LF LAP RESULTANT	4832.29	2.20	334.00	630.00	
RT LAP LOAD X	3348.56	-23.83	335.00	583.00	18
RT LAP LOAD Y	1510.51	-6.80	335.00	598.00	19
RT LAP LOAD Z	3167.71	4.78	334.00	627.00	20
RT LAP RESULTANT	4845.60	7.72	334.00	627.00	

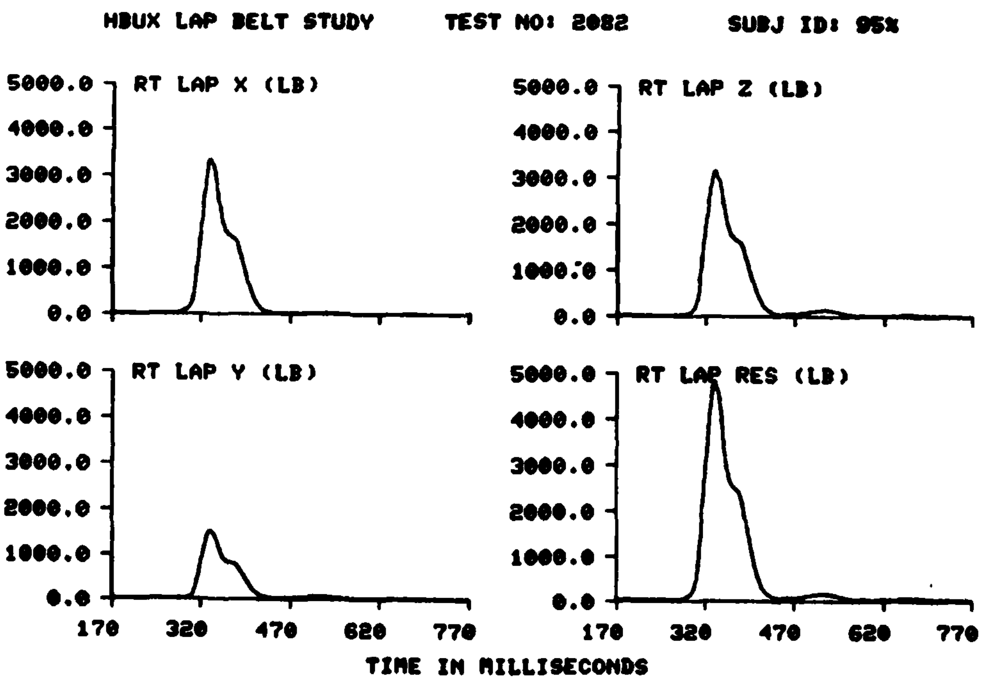
HBUX LAP BELT STUDY TEST NO: 2082 SUBJ ID: 95%



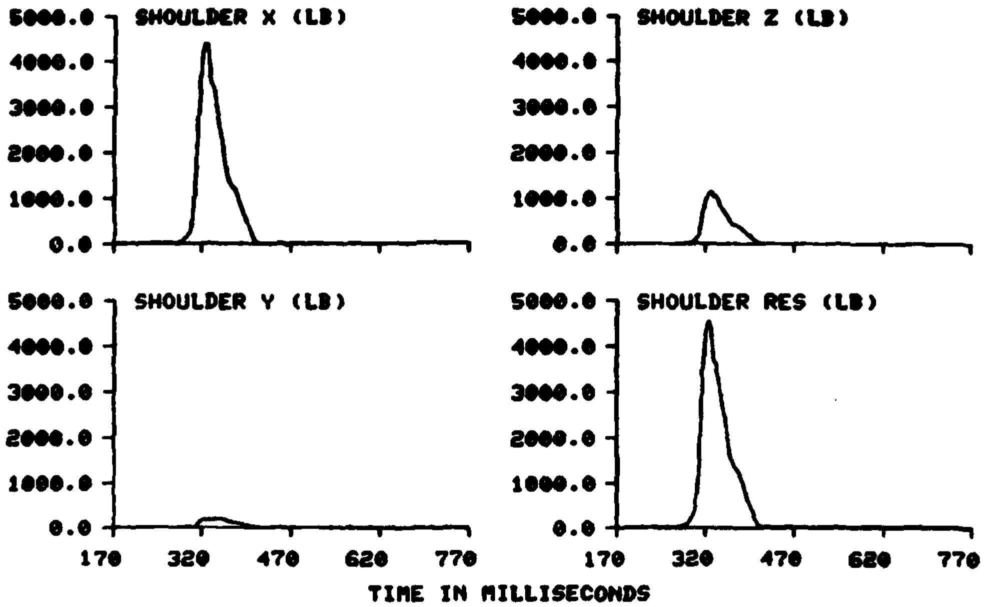
HBUX LAP BELT STUDY TEST NO: 2082 SUBJ ID: 95%




HBUX LAP BELT STUDY
TEST NO: 2082
SUBJ ID: 95%
LF LAP X (LB)
LF LAP Z (LB)
LF LAP Y (LB)
LF LAP RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
170
320
470
620
770
TIME IN MILLISECONDS

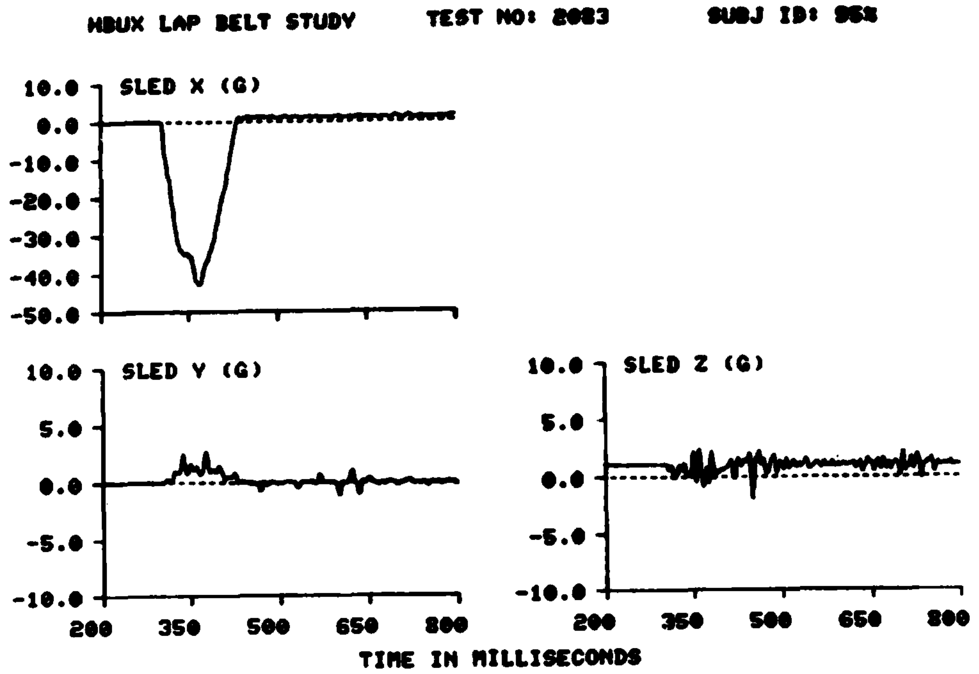

HBUX LAP BELT STUDY
TEST NO: 2082
SUBJ ID: 95%
RT LAP X (LB)
RT LAP Z (LB)
RT LAP Y (LB)
RT LAP RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
170
320
470
620
770
TIME IN MILLISECONDS

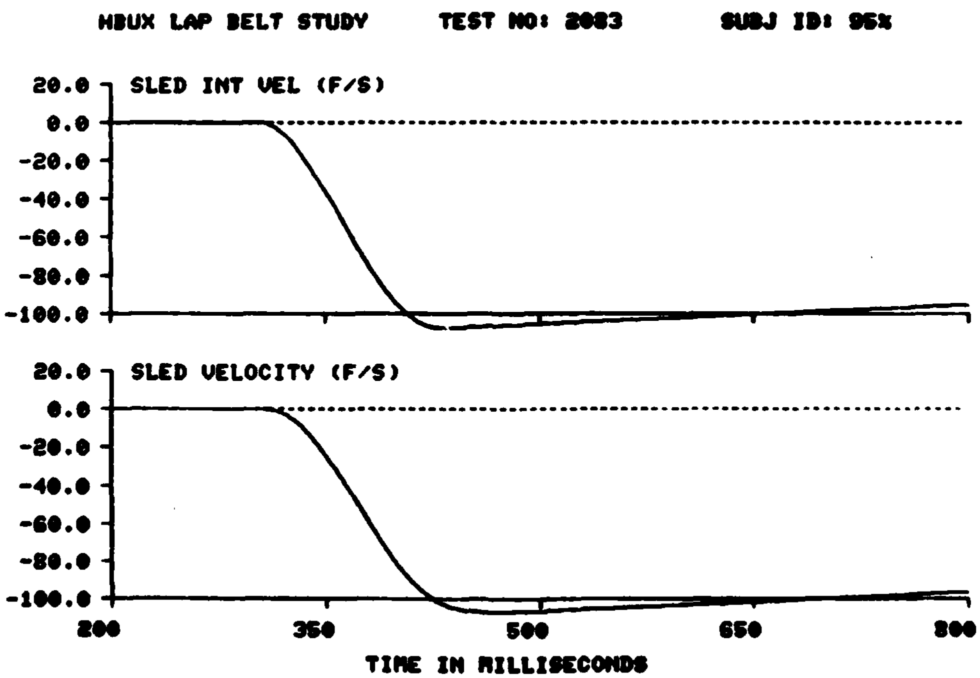
MBUX LAP BELT STUDY TEST NO: 2082 SUBJ ID: 95%

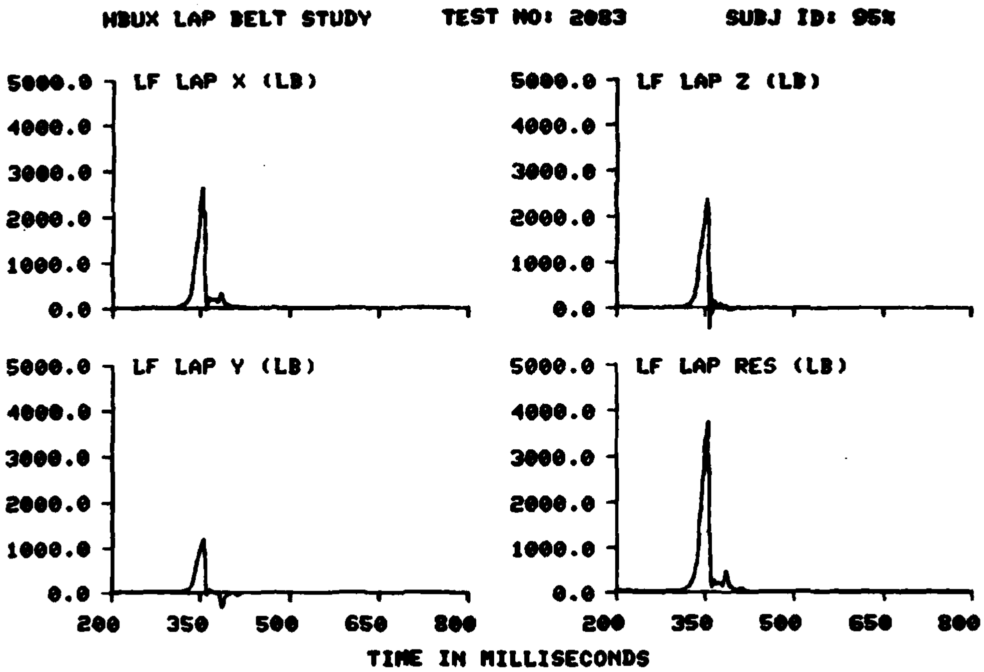


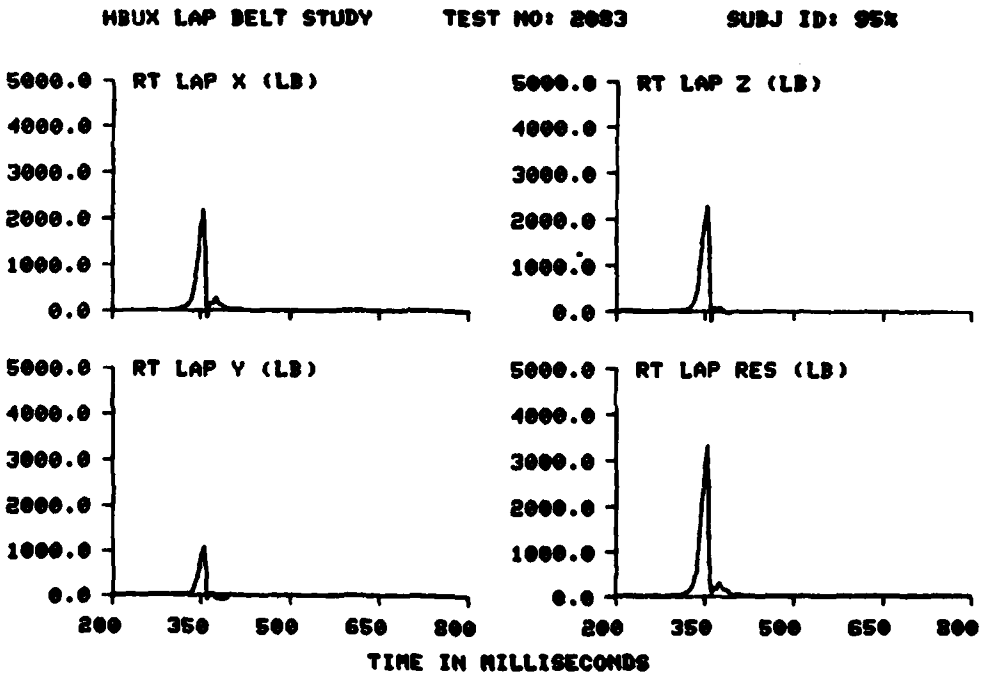
MBUX LAP BELT STUDY TEST: 2083 SUBJ: 95% WT: 204.0 NOM G: 40.0 CELL: X

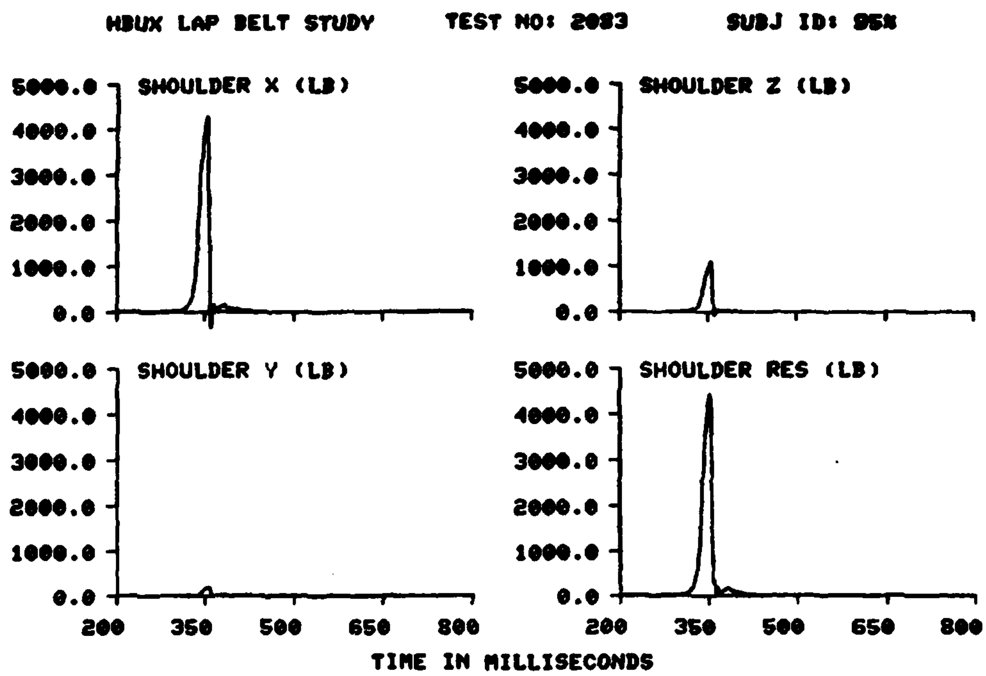
DATA ID	MAX	MIN	T1	T2	CH
TIME OF EVENT			207.00		37
2.5V EXT PWR	2.50	2.49	9.00	118.00	47
10V EXT PWR	10.01	9.98	238.00	36.00	48
SHD PLD PRIOR EVENT	17.91		100.00	200.00	
LF LAP PLD PRIOR EVENT	22.00		100.00	200.00	
RT LAP PLD PRIOR EVENT	20.40		100.00	200.00	
SLED X ACCEL	1.59	-42.86	700.00	367.00	1
SLED X ACCEL (SM)	1.41	-42.40	723.00	367.00	
SLED Y ACCEL	2.67	-1.18	375.00	601.00	2
SLED Z ACCEL	2.38	-1.95	359.00	450.00	3
SLED VEL (INT ACCEL)	0.00	-107.54	200.00	431.00	
SLED VELOCITY	0.21	-107.70	242.00	469.00	29
VEL AT EVENT		-107.70		469.00	
SHOULDER LOAD X	4293.35	-339.13	353.00	360.00	23
SHOULDER LOAD Y	188.02	-26.03	354.00	381.00	22
SHOULDER LOAD Z	1115.16	-77.03	354.00	360.00	21
SHOULDER RESULTANT	4452.41	1.86	353.00	484.00	
LF LAP LOAD X	2640.61	-31.93	354.00	360.00	15
LF LAP LOAD Y	1190.31	-357.92	354.00	385.00	16
LF LAP LOAD Z	2377.73	-453.67	353.00	358.00	17
LF LAP RESULTANT	3739.83	2.64	354.00	448.00	
RT LAP LOAD X	2190.84	-131.46	354.00	360.00	18
RT LAP LOAD Y	1065.27	-114.59	354.00	385.00	19
RT LAP LOAD Z	2277.80	-212.95	353.00	360.00	20
RT LAP RESULTANT	3321.06	1.55	354.00	519.00	


HBUX LAP BELT STUDY
TEST NO: 2083
SUBJ ID: 95%
SLED X (G)
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
SLED Y (G)
10.0
5.0
0.0
-5.0
-10.0
SLED Z (G)
10.0
5.0
0.0
-5.0
-10.0
200
350
500
650
800
TIME IN MILLISECONDS


HBUX LAP BELT STUDY
TEST NO: 2083
SUBJ ID: 95%
SLED INT VEL (F/S)
20.0
0.0
-20.0
-40.0
-60.0
-80.0
-100.0
SLED VELOCITY (F/S)
20.0
0.0
-20.0
-40.0
-60.0
-80.0
-100.0
200
350
500
650
800
TIME IN MILLISECONDS

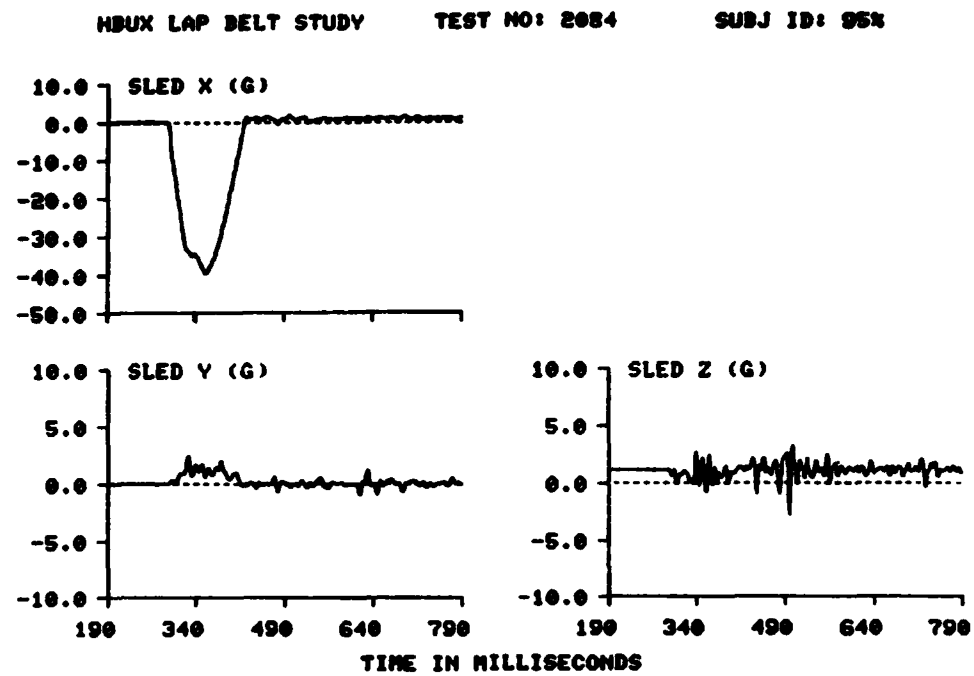

HBUX LAP BELT STUDY
TEST NO: 2083
SUBJ ID: 95%
LF LAP X (LB)
LF LAP Z (LB)
LF LAP Y (LB)
LF LAP RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
200
350
500
650
800
TIME IN MILLISECONDS

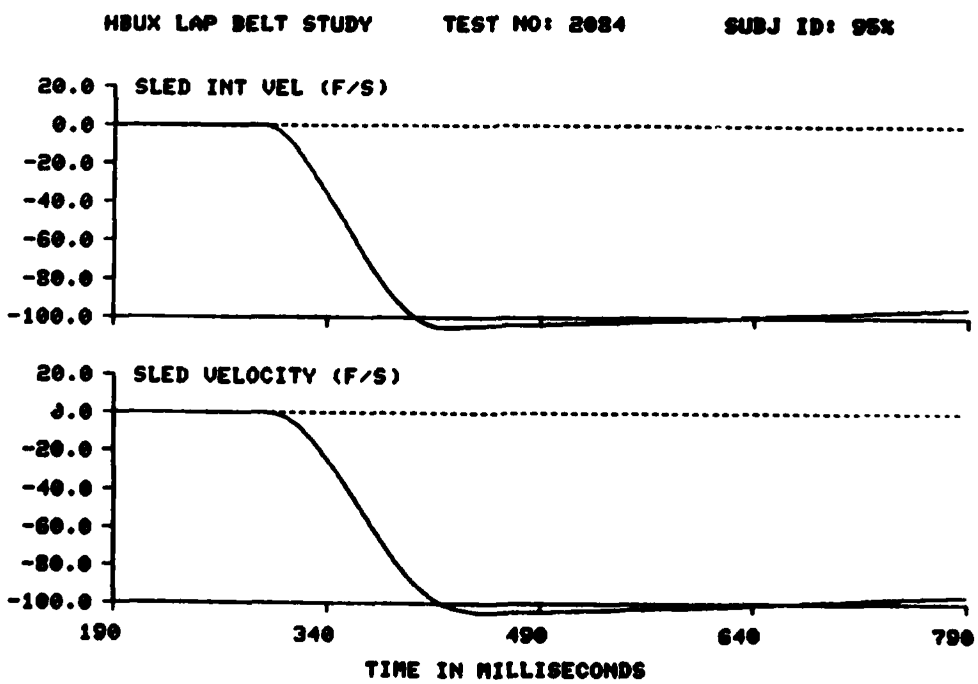

HBUX LAP BELT STUDY
TEST NO: 2083
SUBJ ID: 95%
RT LAP X (LB)
RT LAP Z (LB)
RT LAP Y (LB)
RT LAP RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
200
350
500
650
800
TIME IN MILLISECONDS

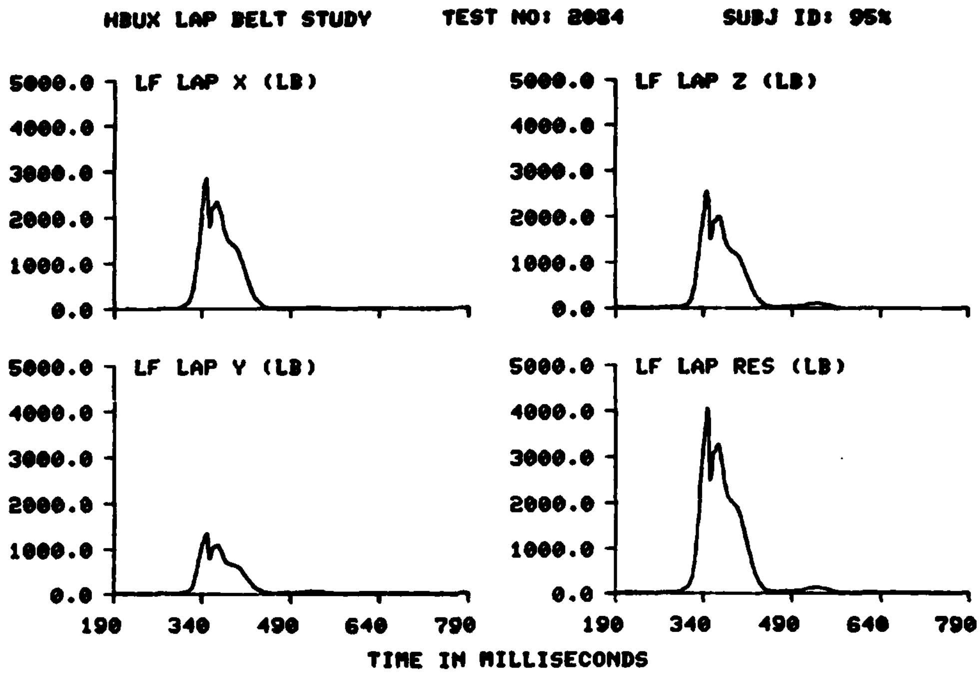

HBUX LAP BELT STUDY
TEST NO: 2083
SUBJ ID: 95%
SHOULDER X (LB)
SHOULDER Z (LB)
SHOULDER Y (LB)
SHOULDER RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
200
350
500
650
800
TIME IN MILLISECONDS

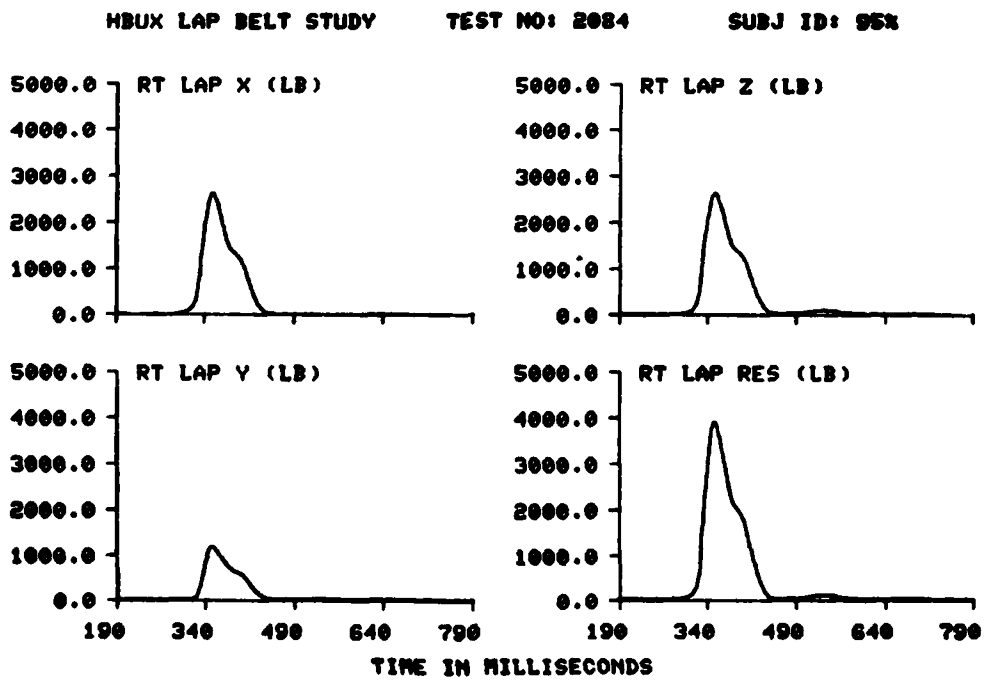
HBUX LAP BELT STUDY TEST: 2084 SUBJ: 95% WT: 204.0 NOM G: 40.0 CELL: X

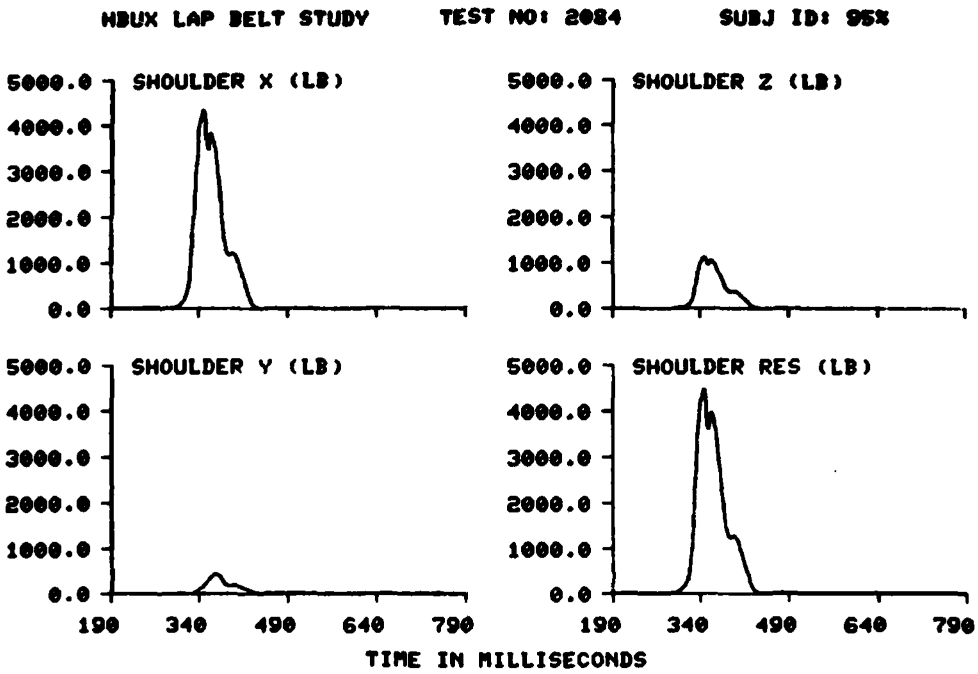
DATA ID	MAX	MIN	T1	T2	CH
TIME OF EVENT			187.00		37
2.5V EXT PWR	2.50	2.49	115.00	17.00	47
10V EXT PWR	10.02	9.98	461.00	60.00	46
SHD PLD PRIOR EVENT	12.30		90.00	190.00	
LF LAP PLD PRIOR EVENT	18.07		90.00	190.00	
RT LAP PLD PRIOR EVENT	21.98		90.00	190.00	
SLED X ACCEL	1.79	-39.52	498.00	356.00	1
SLED X ACCEL (SM)	1.45	-39.10	498.00	357.00	
SLED Y ACCEL	2.42	-0.97	327.00	619.00	2
SLED Z ACCEL	3.22	-2.78	503.00	498.00	3
SLED VEL (INT ACCEL)	0.01	-105.22	216.00	422.00	
SLED VELOCITY	0.20	-105.19	231.00	454.00	29
VEL AT EVENT		-105.19		454.00	
SHOULDER LOAD X	4340.39	-21.93	345.00	480.00	23
SHOULDER LOAD Y	431.82	-16.76	365.00	326.00	22
SHOULDER LOAD Z	1123.19	-10.61	347.00	456.00	21
SHOULDER RESULTANT	4461.89	2.12	345.00	789.00	
LF LAP LOAD X	2844.00	-21.92	347.00	712.00	15
LF LAP LOAD Y	1347.81	-5.72	347.00	582.00	16
LF LAP LOAD Z	2583.48	-11.62	347.00	710.00	17
LF LAP RESULTANT	4059.11	2.50	347.00	595.00	
RT LAP LOAD X	2624.81	-20.60	352.00	665.00	18
RT LAP LOAD Y	1185.58	-9.49	351.00	215.00	19
RT LAP LOAD Z	2831.54	-11.79	352.00	775.00	20
RT LAP RESULTANT	3900.54	4.76	352.00	733.00	


HBUX LAP BELT STUDY
TEST NO: 2084
SUBJ ID: 95%
SLED X (G)
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
SLED Y (G)
10.0
5.0
0.0
-5.0
-10.0
SLED Z (G)
10.0
5.0
0.0
-5.0
-10.0
190
340
490
640
790
TIME IN MILLISECONDS


HBUX LAP BELT STUDY
TEST NO: 2084
SUBJ ID: 95%
SLED INT VEL (F/S)
20.0
0.0
-20.0
-40.0
-60.0
-80.0
-100.0
SLED VELOCITY (F/S)
20.0
0.0
-20.0
-40.0
-60.0
-80.0
-100.0
190
340
490
640
790
TIME IN MILLISECONDS


HBUX LAP BELT STUDY
TEST NO: 2084
SUBJ ID: 95%
LF LAP X (LB)
LF LAP Z (LB)
LF LAP Y (LB)
LF LAP RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
190
340
490
640
790
TIME IN MILLISECONDS


HBUX LAP BELT STUDY
TEST NO: 2084
SUBJ ID: 95%
RT LAP X (LB)
RT LAP Z (LB)
RT LAP Y (LB)
RT LAP RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
190
340
490
640
790
TIME IN MILLISECONDS


HBUX LAP BELT STUDY
TEST NO: 2084
SUBJ ID: 95%
SHOULDER X (LB)
SHOULDER Z (LB)
SHOULDER Y (LB)
SHOULDER RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
190
340
490
640
790
TIME IN MILLISECONDS

HBUX LAP BELT STUDY TEST: 2087 SUBJ: 95% WT: 204.0 NOM G: 40.0 CELL: X

DATA ID	MAX	MIN	T1	T2	CH
TIME OF EVENT			160.00		37
2.5V EXT PWR	2.51	2.49	237.00	5.00	47
10V EXT PWR	10.01	9.98	333.00	14.00	48
SHD PLD PRIOR EVENT	13.29		60.00	160.00	
LF LAP PLD PRIOR EVENT	18.85		60.00	160.00	
RT LAP PLD PRIOR EVENT	22.88		60.00	160.00	
SLED X ACCEL	1.85	-40.36	460.00	314.00	1
SLED X ACCEL (SM)	1.43	-39.90	460.00	315.00	
SLED Y ACCEL	2.37	-1.39	341.00	582.00	2
SLED Z ACCEL	2.86	-2.38	297.00	401.00	3
SLED VEL (INT ACCEL)	0.02	-105.23	204.00	980.00	
SLED VELOCITY	0.14	-105.37	211.00	419.00	29
VEL AT EVENT		-105.37		419.00	
SHOULDER LOAD X	4373.13	-36.87	301.00	442.00	23
SHOULDER LOAD Y	420.21	-7.88	324.00	399.00	22
SHOULDER LOAD Z	1104.26	-7.64	302.00	459.00	21
SHOULDER RESULTANT	4512.69	1.57	301.00	401.00	
LF LAP LOAD X	3158.36	-19.93	304.00	595.00	15
LF LAP LOAD Y	1372.12	-4.88	304.00	196.00	16
LF LAP LOAD Z	2692.67	-1008.01	303.00	282.00	17
LF LAP RESULTANT	4497.28	5.21	304.00	600.00	
RT LAP LOAD X	2557.46	-12.22	304.00	230.00	18
RT LAP LOAD Y	1950.26	-4.67	304.00	160.00	19
RT LAP LOAD Z	2584.28	-1.32	305.00	169.00	20
RT LAP RESULTANT	3878.44	11.65	305.00	173.00	

AD-A148 034 IMPACT TESTS OF AUTOMATIC LAP BELT CONFIGURATIONS(U) 2/2
AIR FORCE AEROSPACE MEDICAL RESEARCH LAB
WRIGHT-PATTERSON AFB OH J W BRINKLEY ET AL. 02 JUL 84
UNCLASSIFIED AFAMRL-TR-041 F/G 6/11 NL

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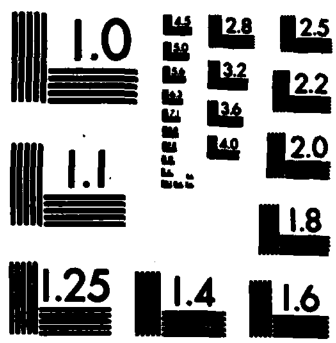
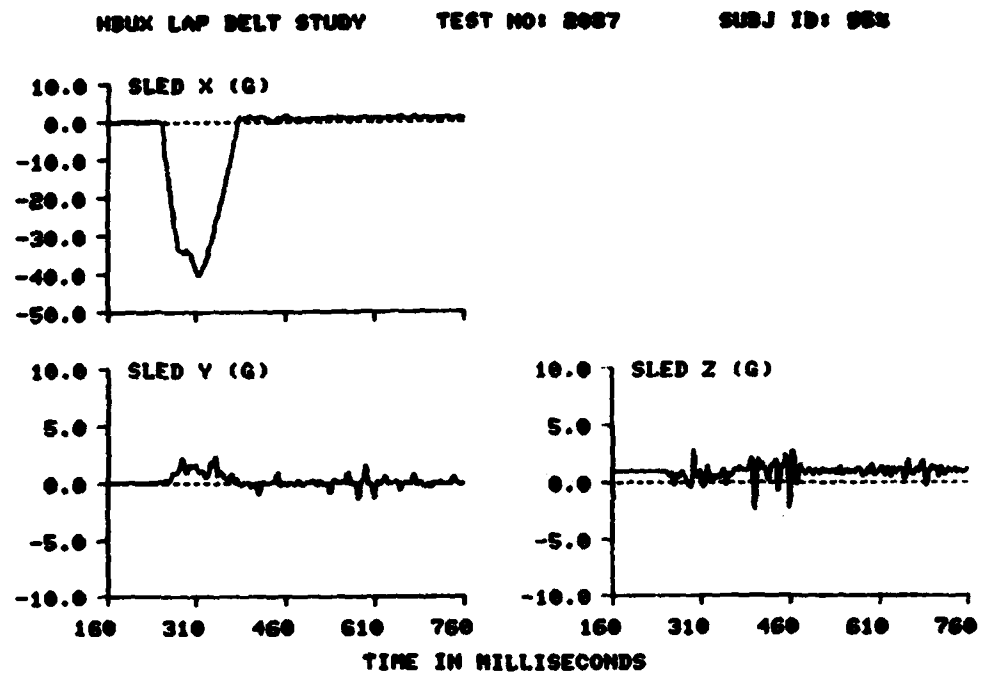
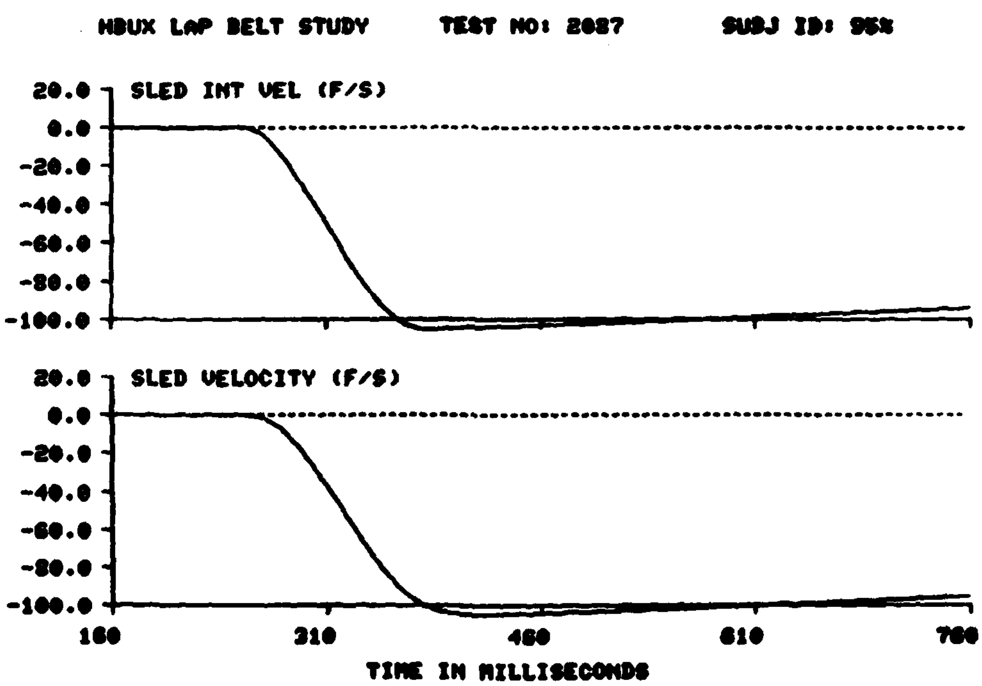
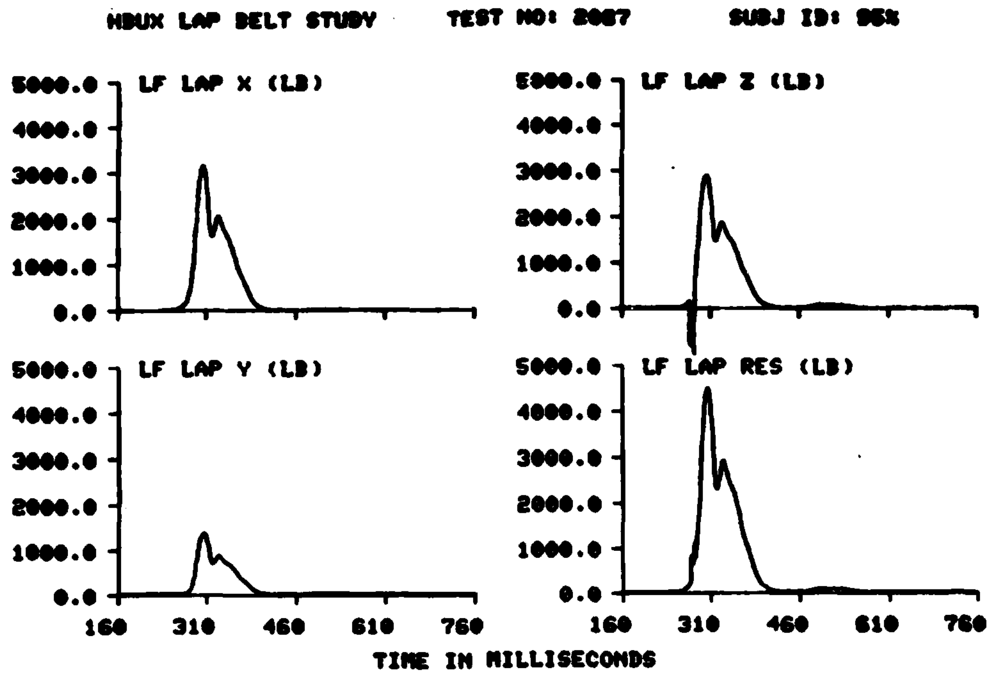
DTIC

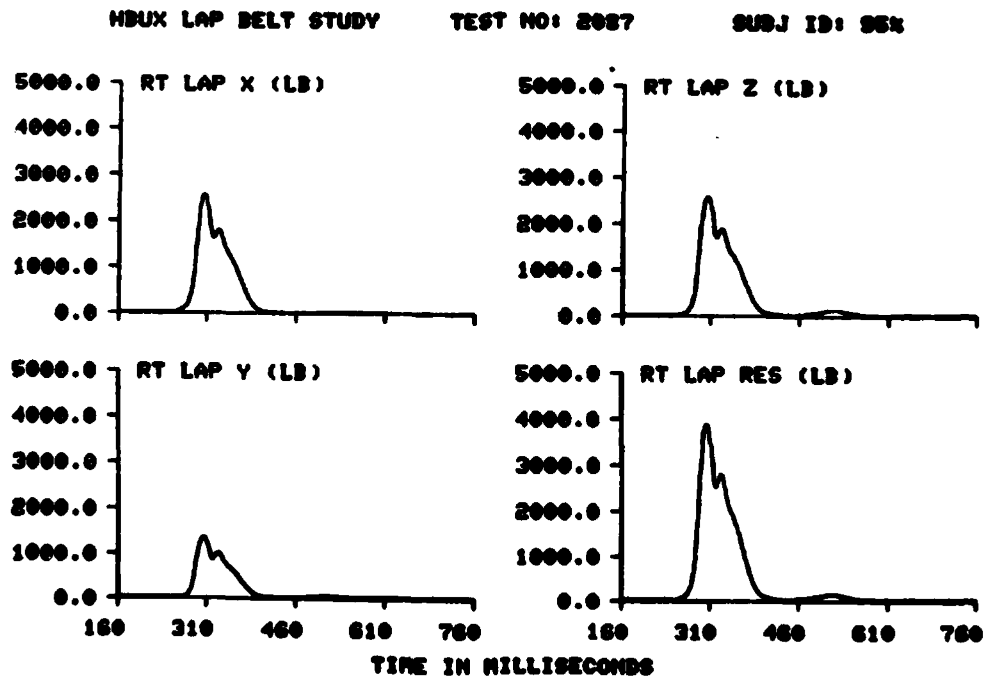


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

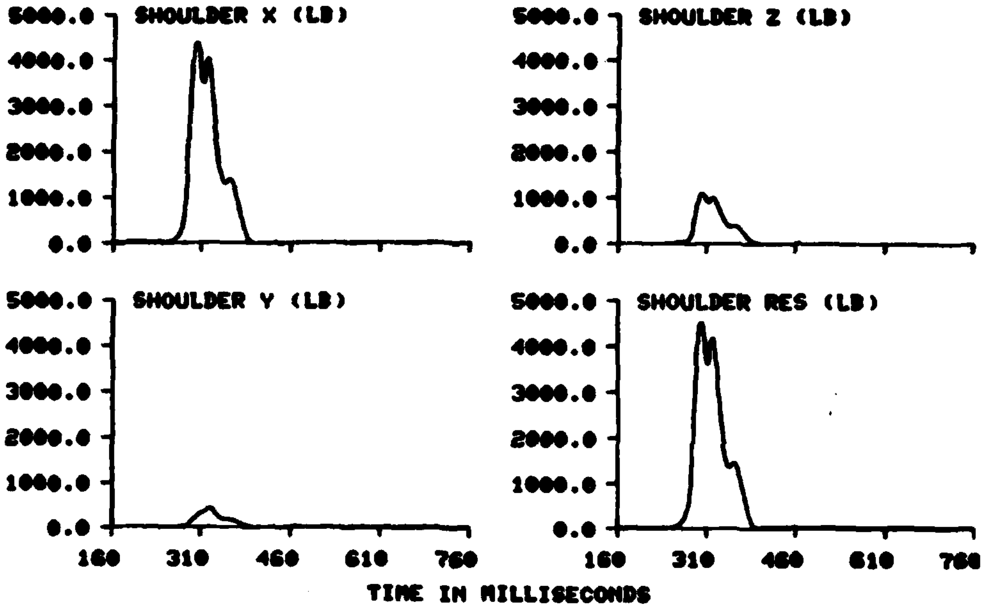

HBUX LAP BELT STUDY
TEST NO: 2087
SUBJ ID: 95%
SLED X (G)
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
SLED Y (G)
SLED Z (G)
10.0
5.0
0.0
-5.0
-10.0
160
310
460
610
760
TIME IN MILLISECONDS


HBUX LAP BELT STUDY
TEST NO: 2087
SUBJ ID: 95%
SLED INT VEL (F/S)
SLED VELOCITY (F/S)
20.0
0.0
-20.0
-40.0
-60.0
-80.0
-100.0
160
310
460
610
760
TIME IN MILLISECONDS


HBUX LAP BELT STUDY
TEST NO: 2087
SUBJ ID: 95%
LF LAP X (LB)
LF LAP Z (LB)
LF LAP Y (LB)
LF LAP RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
160
310
460
610
760
TIME IN MILLISECONDS

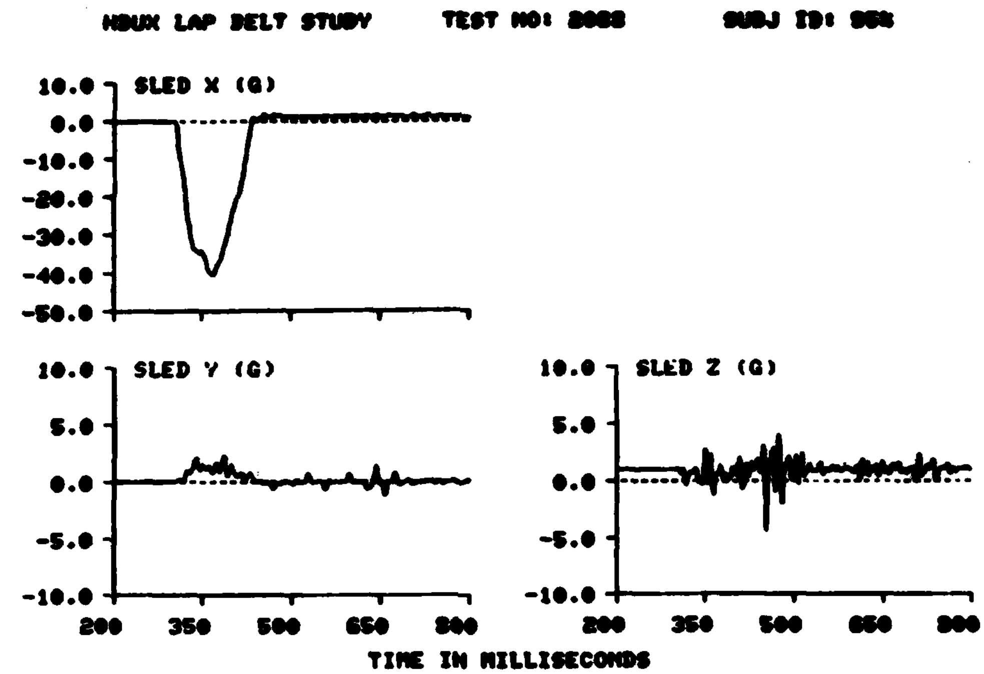

HBUX LAP BELT STUDY
TEST NO: 2087
SUBJ ID: 95%
RT LAP X (LB)
RT LAP Z (LB)
RT LAP Y (LB)
RT LAP RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
160
310
460
610
760
TIME IN MILLISECONDS

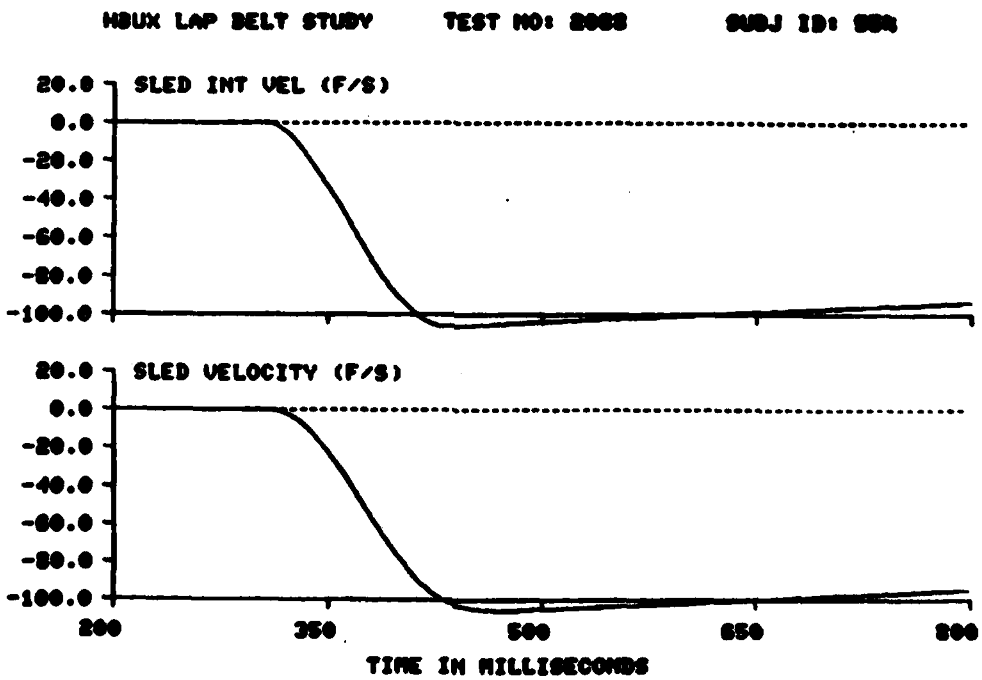
HBUX LAP BELT STUDY TEST NO: 2087 SUBJ ID: 95%

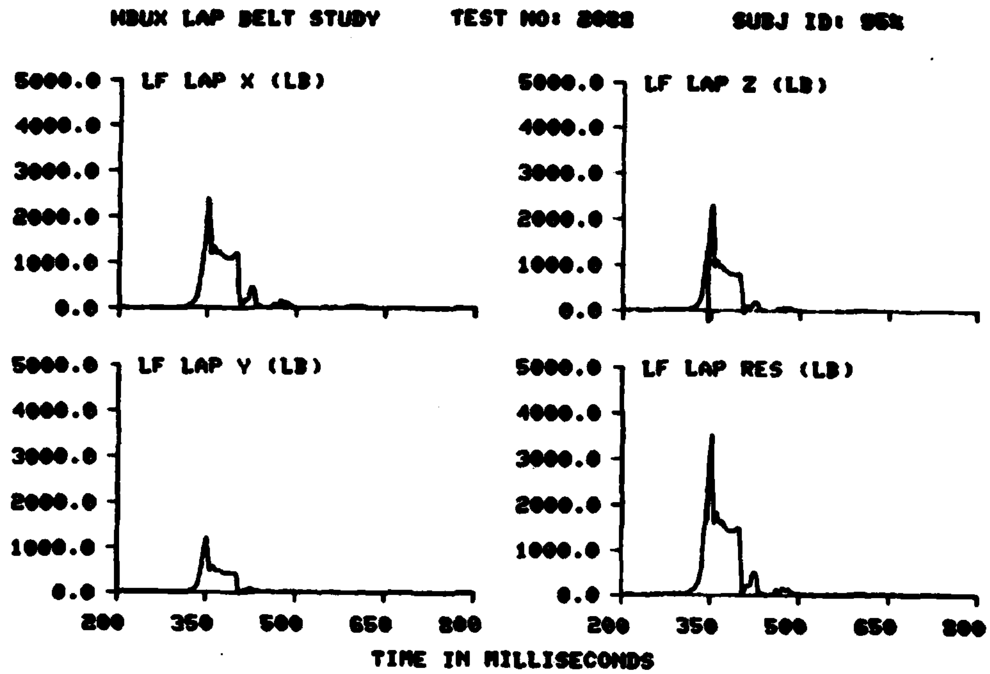


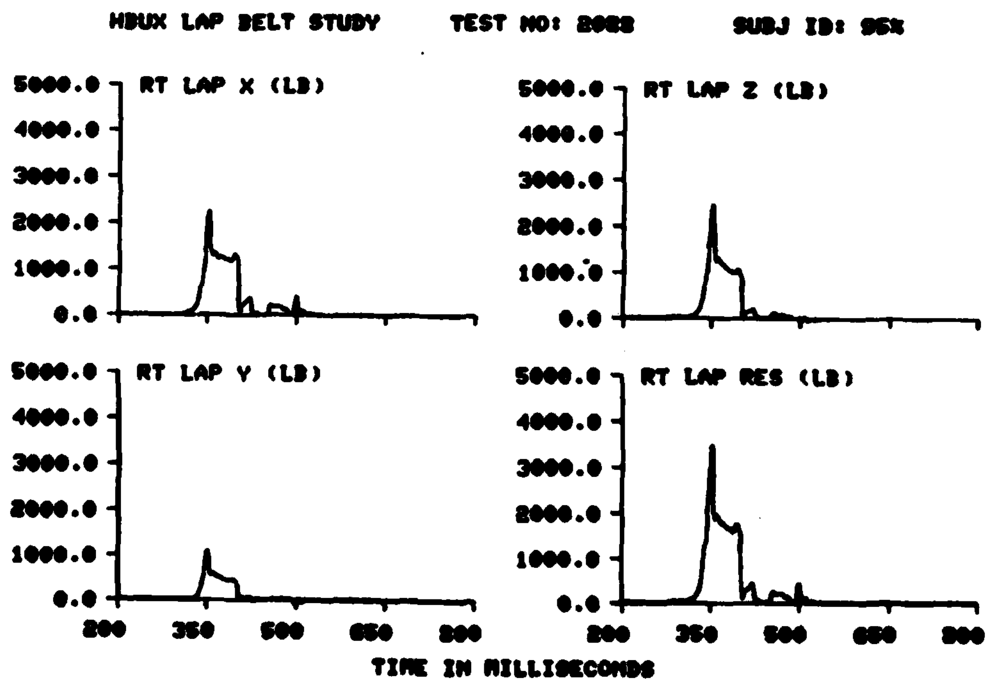
HBUX LAP BELT STUDY TEST: 2088 SUBJ: 95% WT: 204.0 NOM G: 40.0 CELL: X

DATA ID	MAX	MIN	T1	T2	CH
TIME OF EVENT			207.00		37
2.5V EXT PWR	2.51	2.49	177.00	97.00	47
10V EXT PWR	10.01	9.98	540.00	88.00	48
SHD PLD PRIOR EVENT	18.39		100.00	200.00	
LF LAP PLD PRIOR EVENT	18.28		100.00	200.00	
RT LAP PLD PRIOR EVENT	19.81		100.00	200.00	
SLED X ACCEL	1.77	-40.62	454.00	368.00	1
SLED X ACCEL (SM)	1.43	-40.10	471.00	367.00	
SLED Y ACCEL	2.29	-1.18	306.00	658.00	2
SLED Z ACCEL	4.03	-4.30	475.00	454.00	3
SLED VEL (INT ACCEL)	0.00	-106.16	238.00	433.00	
SLED VELOCITY	0.27	-106.18	273.00	471.00	29
VEL AT EVENT		-106.18		471.00	
SHOULDER LOAD X	4118.90	-77.16	373.00	408.00	23
SHOULDER LOAD Y	300.80	-77.19	365.00	431.00	22
SHOULDER LOAD Z	1547.07	-12.51	401.00	408.00	21
SHOULDER RESULTANT	4282.94	1.72	373.00	568.00	
LF LAP LOAD X	2384.96	-24.79	351.00	504.00	15
LF LAP LOAD Y	1213.68	-28.60	351.00	406.00	16
LF LAP LOAD Z	2909.89	-257.19	351.00	345.00	17
LF LAP RESULTANT	3535.06	1.25	351.00	448.00	
RT LAP LOAD X	2262.94	-23.93	352.00	635.00	18
RT LAP LOAD Y	1093.99	-129.00	352.00	499.00	19
RT LAP LOAD Z	2458.26	-77.88	351.00	500.00	20
RT LAP RESULTANT	3484.39	1.46	351.00	568.00	

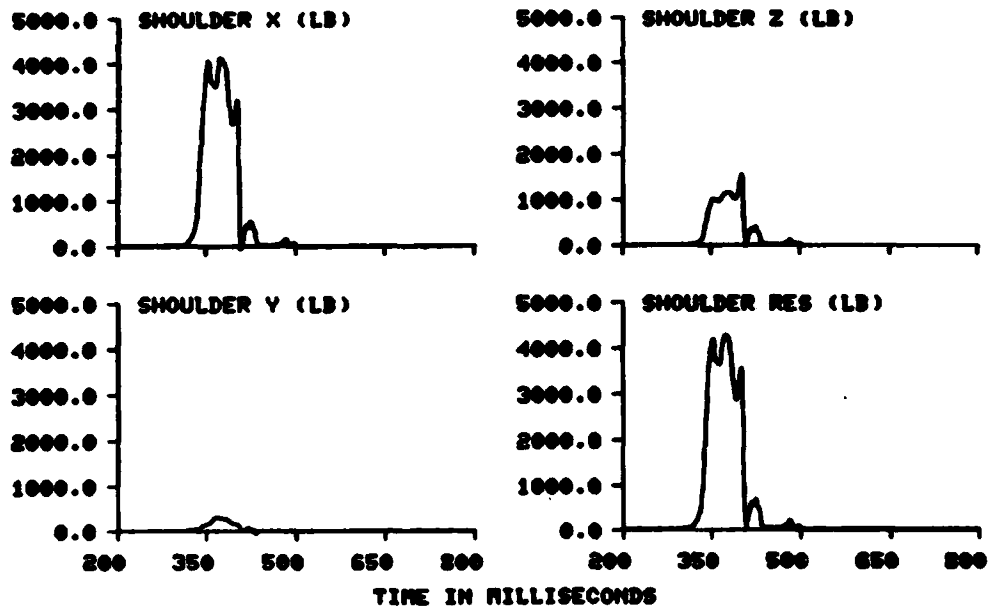

LAP BELT STUDY
TEST NO:
SUBJ ID:
SLED X (G)
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
SLED Y (G)
SLED Z (G)
10.0
5.0
0.0
-5.0
-10.0
200
350
500
650
800
TIME IN MILLISECONDS


LAP BELT STUDY
TEST NO:
SUBJ ID:
SLED INT VEL (F/S)
SLED VELOCITY (F/S)
20.0
0.0
-20.0
-40.0
-60.0
-80.0
-100.0
200
350
500
650
800
TIME IN MILLISECONDS


HBUX LAP BELT STUDY
TEST NO:
SUBJ ID: 95%
LF LAP X (LB)
LF LAP Z (LB)
LF LAP Y (LB)
LF LAP RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
200
350
500
650
800
TIME IN MILLISECONDS


HBUX LAP BELT STUDY
TEST NO:
SUBJ ID: 95%
RT LAP X (LB)
RT LAP Z (LB)
RT LAP Y (LB)
RT LAP RES (LB)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
200
350
500
650
800
TIME IN MILLISECONDS

HBUX LAP BELT STUDY TEST NO: 2088 SUBJ ID: 95%



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